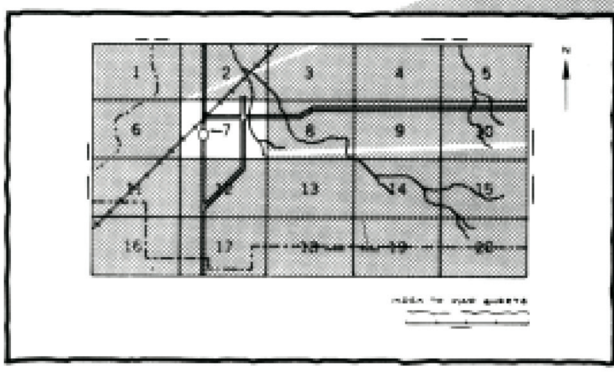
Soil Survey of

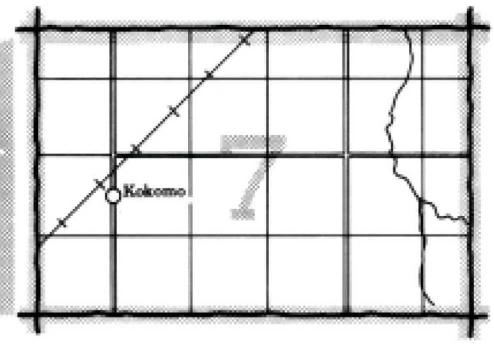
Franklin County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

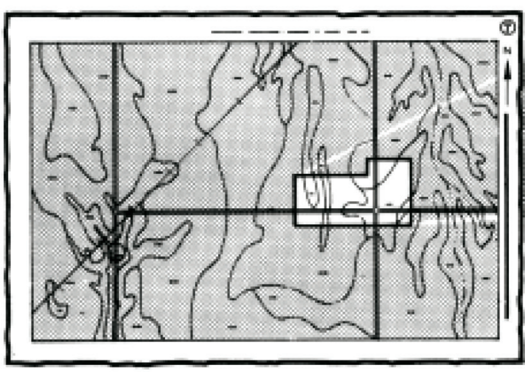
1. Locate your area of interest on the "Index to Map Sheets"

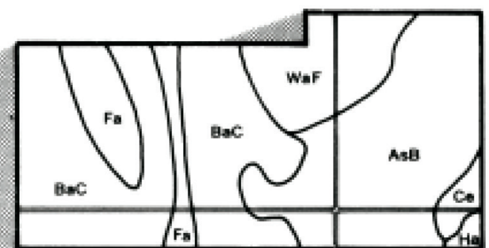




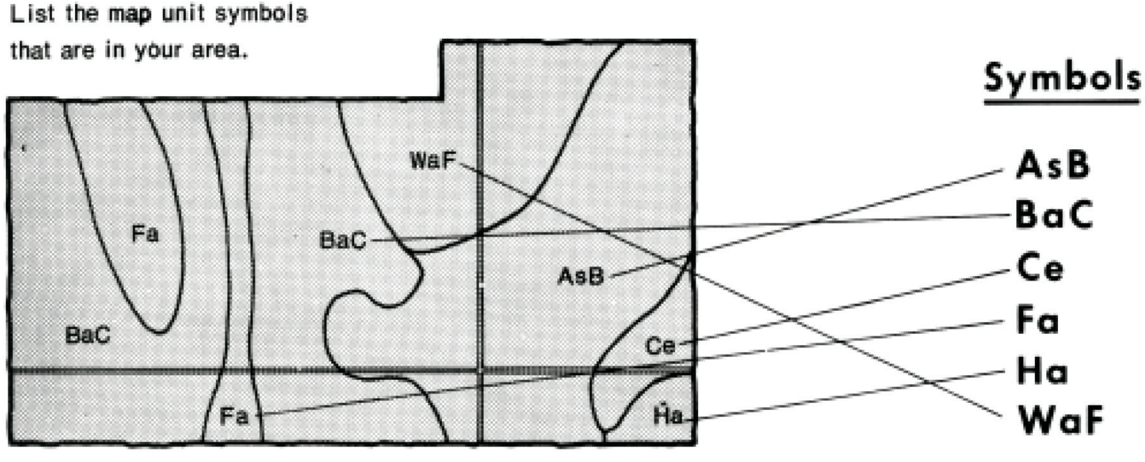
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



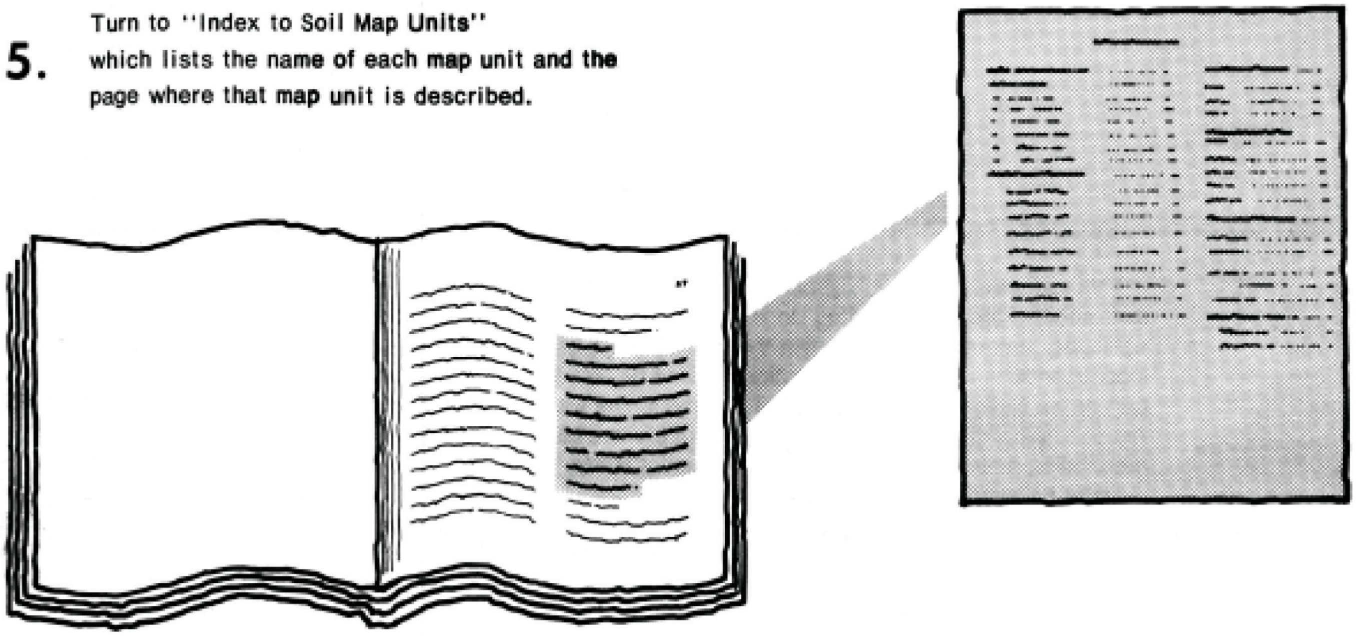


4. List the map unit symbols that are in your area.

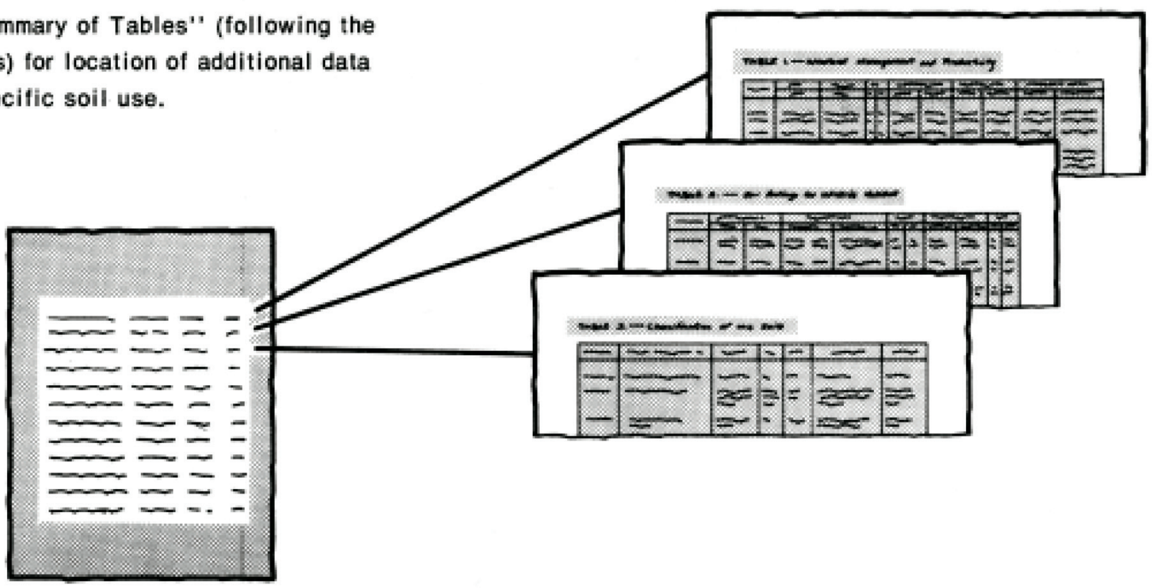


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Franklin County Conservation District. Major fieldwork was performed in the period 1941 to 1951. The survey was revised and updated in the period 1976 to 1979. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Native grass on Eram, Lula, and Summit soils.

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soil series

Issued July 1981

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foreword

This soil survey contains information that can be used in land-planning programs in Franklin County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service

soil survey of
Franklin County, Kansas

By Harold P. Dickey, Soil Conservation Service

Soils surveyed by O. W. Tate, S. P. Hertha, and E. L. Bell,
Soil Conservation Service, during the period 1941-51, and by
Harold Penner, Soil Conservation Service, during the period 1976-79

United States Department of Agriculture, Soil Conservation Service,
in cooperation with the Kansas Agricultural Experiment Station

FRANKLIN COUNTY is in the east-central part of Kansas (fig. 1). It has a total area of 369,280 acres, or 576 square miles. In 1978, it had a population of 21,399, about 50 percent of which lives in Ottawa, the county seat. This town is near the center of the county, along the Marais Des Cygnes River.

Farming is the principal economic enterprise. Livestock and cash grain farming are of equal importance to the local economy. Also important are various industries and Ottawa University. Soybeans, wheat, grain sorghum, and corn are the chief crops.

This county was originally a part of the Osage Indian Reservation. In July of 1855, it was established by the First Territorial Legislature as one of the original 33 counties in the territory. It was named in honor of Benjamin Franklin. Ottawa was organized in September of 1864. It was named in honor of the Ottawa Indians.

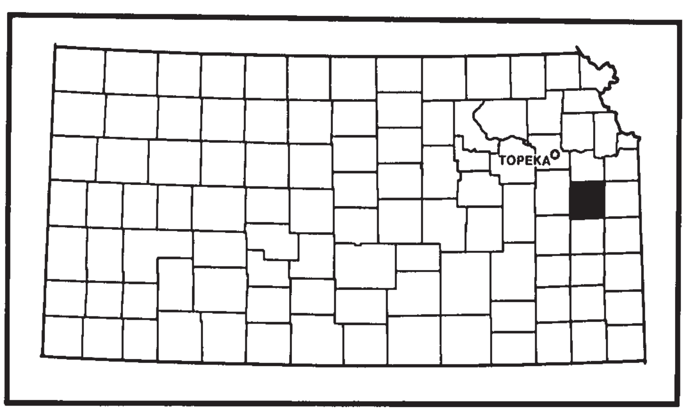

Figure 1.—Location of Franklin County in Kansas.

general nature of the county

This section gives general information concerning the county. It describes climate; physiography, drainage, and relief; water supply; and natural resources.

climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Franklin County is typical continental, as would be expected of a location in the interior of a large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of the frequent outbreaks of polar air. They last from December to February. Warm summer temperatues last for about 6 months every year. They provide a long growing season for the crops commonly grown in the county. Spring and fall generally are short.

Franklin County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during thunderstorms late in the evening or at night. Although the total precipitation is generally adequate for any crop, its distribution causes problems in some years. Prolonged dry periods of several weeks occasionally occur during the growing season.

Tornadoes and severe thunderstorms occur occasionally. These storms usually are local in extent and of short duration, so that the risk of crop damage is small. Hail falls in scattered small areas during the warmer part of the year. Because they are infrequent and of local extent, the hailstorms in this county cause less crop damage than those in western Kansas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Ottawa in the period 1951 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 33.4 degrees F, and the average daily minimum temperature is 23.0 degrees. The lowest temperature on record, which occurred at Ottawa on February 13, 1905, is -28 degrees. In summer the average temperature is 77.3 degrees, and the average daily maximum temperature is 88.8 degrees. The highest recorded temperature, which occurred at Ottawa on July 14, 1954, is 118 degrees.

The total annual precipitation is 38.60 inches. Of this, 27.09 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 21.67 inches. The heaviest 1-day rainfall was 6.95 inches at Ottawa on November 16, 1928.

Average seasonal snowfall is 23.8 inches. The greatest snowfall, which occurred during the winter of 1959-60, was 62.5 inches. On an average of 22 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 74 percent of the time possible in summer and 58 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in March.

physiography, drainage, and relief

Franklin County is in the Osage Plains section of the Central Lowland physiographic province (*3*). The land resource area is the Cherokee Prairies. The major topographic features are the east trending valley of the Marais Des Cygnes River, the northeast trending valley of Pottawatomie Creek, and upland cuestas, which formed through differential erosion of limestone, shale, and sandstone strata. The landscape generally is nearly level to rolling. In a few areas relief is strong.

The Marais Des Cygnes River and its tributaries drain all of the county. The highest elevation, in the northwestern part of the county, is about 1,145 feet above sea level. The lowest, along the Marais Des Cygnes River in the eastern part, is about 840 feet. The average gradient of this river is about 2 feet per mile.

water supply

The Marais Des Cygnes River and Pottawatomie Creek are the major sources of water in the county. In some areas in the western part of the county, however, ground water is available from wells. These wells generally yield enough water for domestic uses. Only a few wells yield dependable water supplies in the eastern part of the county. The main source of water for livestock is surface water impounded by dams and local streams. Rural water districts supply most of the water needed in rural areas.

natural resources

Soil is the most important natural resource in the county. It provides a growing medium for cash crops and for the grasses grazed by livestock.

Other mineral resources are limestone, shale, oil, gas, and gravel. The limestone is quarried and crushed for various uses, such as road surfacing and agricultural lime. The shale is mined and then expanded to larger particles and used as aggregate material and decorative gravel.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those

characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

soil descriptions

1. Lula-Eram-Summit association

Deep and moderately deep, nearly level to strongly sloping, well drained and moderately well drained soils on uplands

This association is on ridgetops and side slopes that are dissected by many drainageways. The slope generally ranges from 0 to 20 percent. In a few places along drainageways, however, it is more than 20 percent.

This association makes up about 46 percent of the county. It is about 25 percent Lula soils, 20 percent Eram soils, 13 percent Summit soils, and 42 percent minor soils (fig. 2).

The deep, well drained, nearly level to moderately sloping Lula soils are on ridgetops. Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil is silty clay loam about 37 inches thick. The upper part is dark brown and firm, and the lower part is dark reddish brown and reddish brown and firm and very firm. Limestone is at a depth of about 44 inches.

The moderately deep, moderately well drained, moderately sloping and strongly sloping Eram soils are on side slopes below areas where limestone crops out. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, very firm silty clay, and the lower part is coarsely mottled yellowish brown and light brownish gray, firm silty clay loam. Weathered shale is at a depth of about 38 inches.

The deep, moderately well drained, gently sloping and moderately sloping Summit soils are on side slopes or foot slopes. Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is about 51 inches thick. The upper part is very dark gray, firm silty clay loam, and the lower part is very dark grayish brown and dark grayish brown, very firm silty clay. The substratum to a depth of about 60 inches is dark brown silty clay loam.

Of minor extent in this association are Clareson, Kenoma, Lebo, Verdigris, and Woodson soils. The strongly sloping Clareson soils have flaggy limestone in the subsoil, and the steep Lebo soils have shale fragments in the subsoil. Both of these soils are on the upper side slopes. The deep Kenoma and Woodson soils have a clayey subsoil. They are gently sloping and are on ridgetops. The deep, nearly level Verdigris soils are on flood plains along drainageways.

About 60 percent of this association is used as rangeland or pasture, and 40 percent is cultivated. Limestone quarries are in a few areas. Livestock farming and general cash grain farming are the main farm enterprises. The principal crops are wheat, soybeans, grain sorghum, and corn. The main management needs are measures that maintain or increase grass production on rangeland or pasture and control erosion and maintain or improve fertility and tilth in the cultivated areas.

2. Dennis-Bates-Woodson association

Deep and moderately deep, nearly level to moderately sloping, well drained to somewhat poorly drained soils on uplands

This association is on broad ridgetops and side slopes that are dissected by drainageways. The slope ranges from 0 to 7 percent.

This association makes up about 26 percent of the county. It is about 30 percent Dennis soils, 25 percent

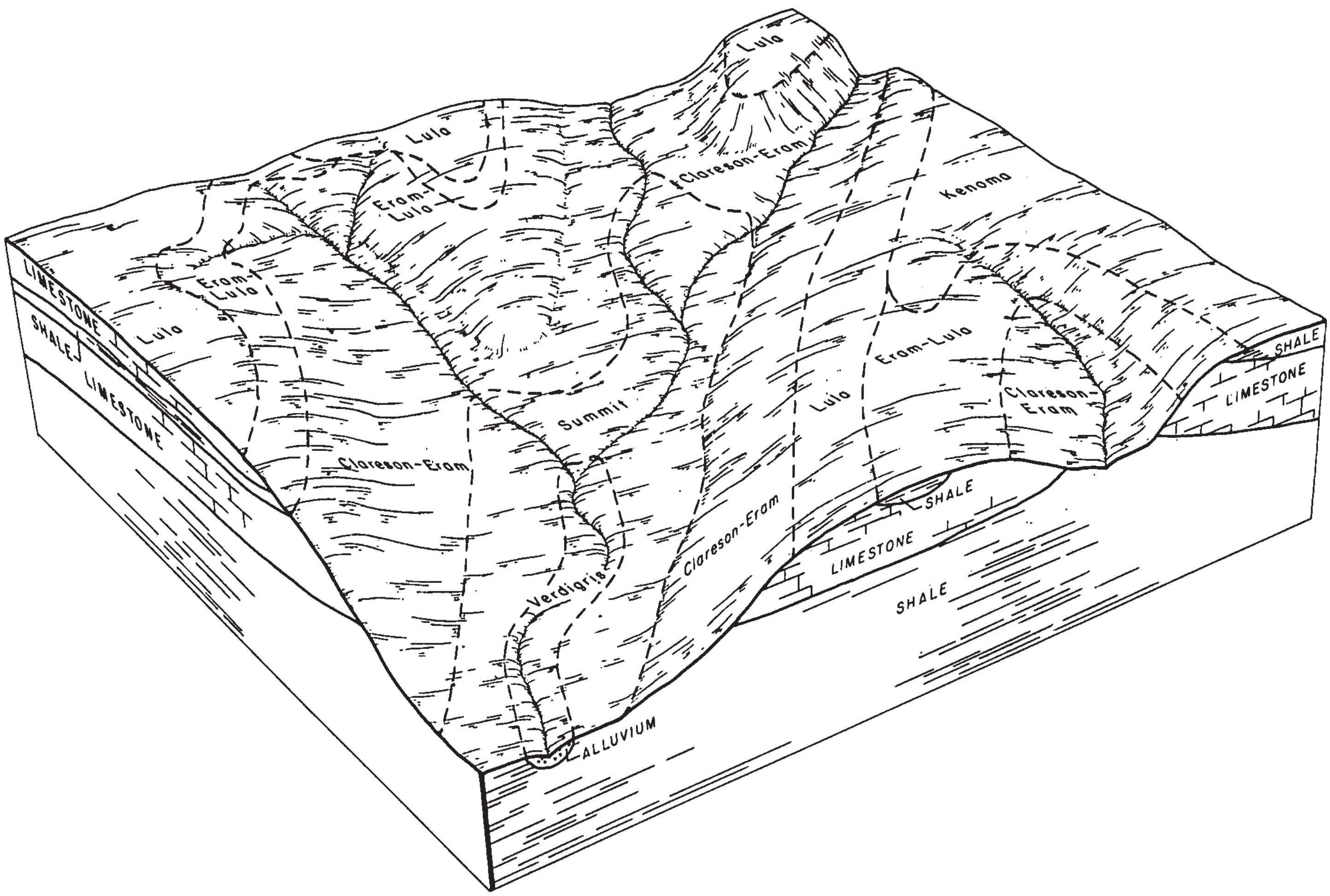

Figure 2.—Typical pattern of soils and parent material in the Lula-Eram-Summit association.

Bates soils, 20 percent Woodson soils, and 25 percent minor soils (fig. 3).

The deep, moderately well drained Dennis soils are on ridgetops and side slopes. They are gently sloping on the ridgetops and gently sloping and moderately sloping on the side slopes. Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, friable silty clay loam, the next part is olive brown and yellowish brown, firm and very firm silty clay, and the lower part is yellowish brown and olive brown, firm silty clay loam.

The moderately deep, well drained Bates soils are on ridgetops and side slopes. They are gently sloping on the ridgetops and moderately sloping on the side slopes. Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is friable loam about 23 inches thick. The upper part is dark brown, and the lower part is yellowish brown. Sandstone is at a depth of about 34 inches.

The deep, somewhat poorly drained, nearly level and gently sloping Woodson soils are on broad ridgetops. Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 31 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is coarsely mottled gray and yellowish brown silty clay loam.

Of minor extent in this association are Bolivar, Collinsville, Hector, Kenoma, and Verdigris soils. The moderately sloping Bolivar soils have a dark surface layer that is less than 7 inches thick. They are on ridgetops and the upper side slopes. The shallow, strongly sloping Collinsville and Hector soils are on the upper side slopes. The gently sloping Kenoma soils are on ridgetops and the upper side slopes. The Verdigris soils are on flood plains along drainageways.

About half of this association is cultivated (fig. 4). The rest generally is used as pasture. Livestock farming and

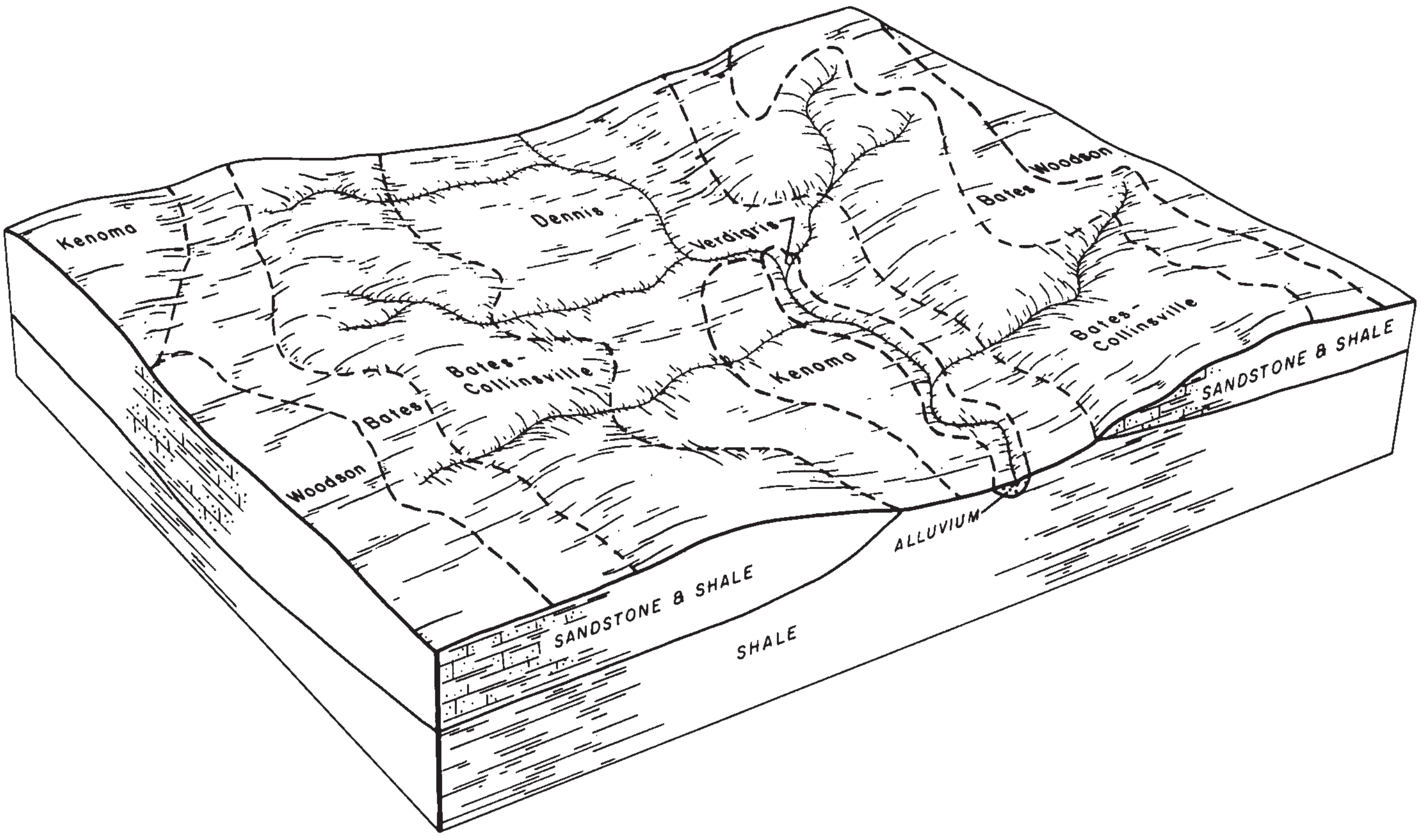

Figure 3.—Typical pattern of soils and parent material in the Dennis-Bates-Woodson association.

general cash grain farming are the main farm enterprises. The main crops are soybeans, wheat, grain sorghum, and corn. The main management needs are measures that control erosion and maintain or improve tilth and fertility in the cultivated areas and maintain or increase grass production on pasture.

3. Kenoma-Woodson association

Deep, nearly level and gently sloping, moderately well drained and somewhat poorly drained soils on uplands

This association is on broad ridgetops that are dissected by shallow drainageways. The slope ranges from 0 to 4 percent.

This association makes up about 18 percent of the county. It is about 47 percent Kenoma soils, 43 percent Woodson soils, and 10 percent minor soils (fig. 5).

The moderately well drained, gently sloping Kenoma soils are on ridgetops. Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil to a depth of about 60 inches is very firm silty clay. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is coarsely mottled reddish brown, dark brown, and brown.

The somewhat poorly drained, nearly level and gently sloping Woodson soils are on broad ridgetops. Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 31 inches thick. It is very dark gray in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is coarsely mottled gray and yellowish brown silty clay loam.

Of minor extent in this association are Dennis, Leanna, and Verdigris soils. The Dennis soils have silty clay loam in the upper part of the subsoil. They are moderately sloping and are on the side slopes. The Leanna and Verdigris soils are nearly level and are on flood plains along drainageways.

Most of this association is cultivated. Some areas are used as tame pasture or are developed for urban use. Most of the cities and towns in the county are on this association. The main crops are soybeans, wheat, grain sorghum, and corn. The main management needs are measures that control erosion and maintain fertility and tilth.

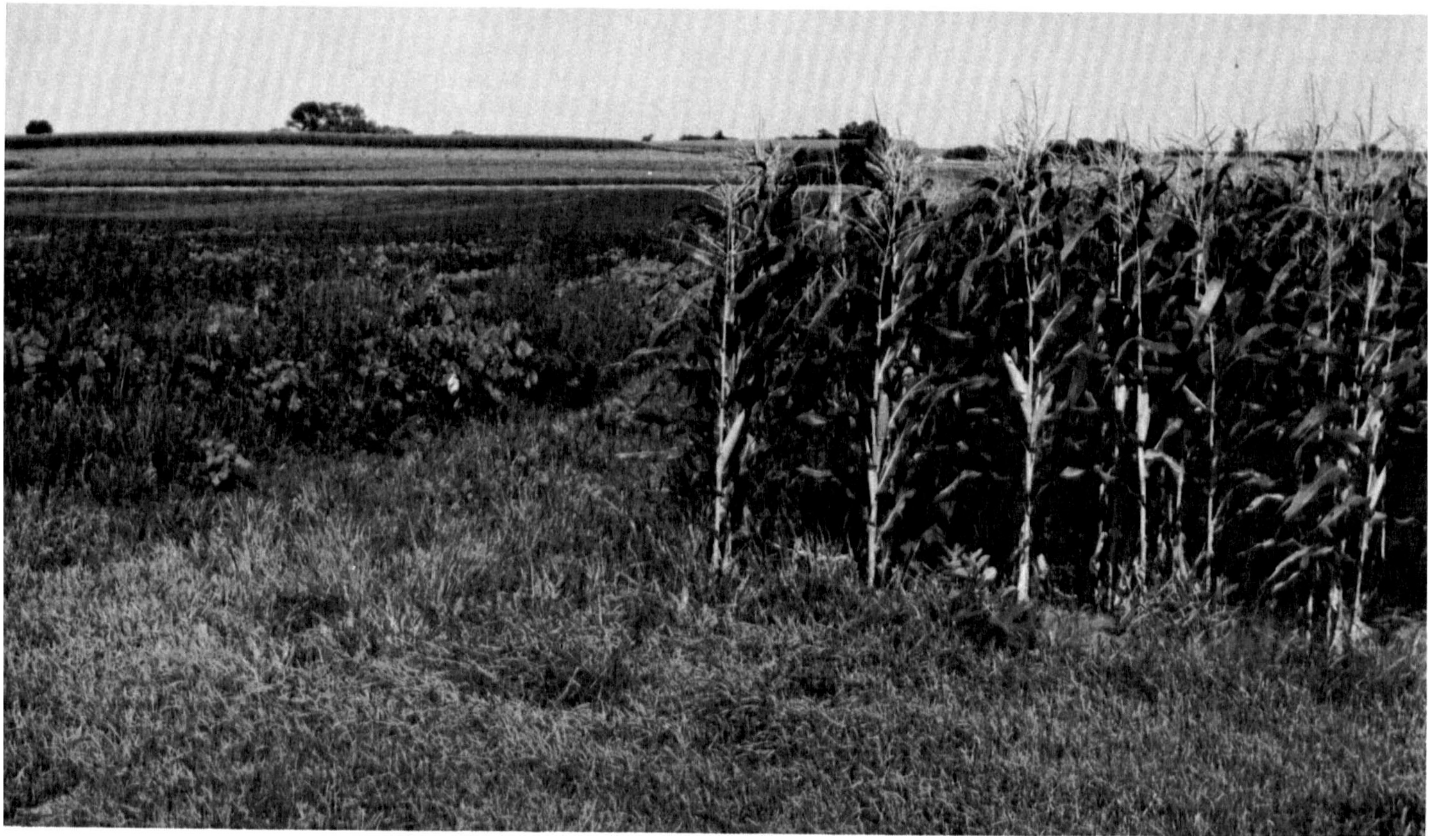

Figure 4.—Corn and soybeans in an area of the Dennis-Bates-Woodson association.

4. Verdigris-Osage association

Deep, nearly level, well drained and poorly drained soils on bottom land

This association is on flood plains and stream terraces. The slope generally is less than 1 percent but is steeper along the stream channels.

This association makes up about 10 percent of the county. It is about 55 percent Verdigris soils, 35 percent Osage soils, and 10 percent minor soils.

The well drained Verdigris soils are on flood plains adjacent to streams. They are occasionally or frequently flooded. Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark brown silt loam about 9 inches thick. The next 12 inches is very dark grayish brown, friable silty clay loam. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam.

The poorly drained Osage soils are on flood plains. They are occasionally flooded. Typically, the surface soil is very dark gray silty clay about 17 inches thick. The subsoil is very dark gray, very firm silty clay about 33 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay.

Of minor extent in this association are Dennis, Kenoma, Leanna, Mason, and Woodson soils. The deep Dennis, Kenoma, and Woodson soils are on uplands or high terraces. They have a clayey subsoil. The Leanna soils are on flood plains and low terraces. Their subsurface layer is lighter colored than that of the major soils. The Mason soils are on terraces and are subject to rare flooding.

Most of this association is used for cultivated crops. A few areas are used as pasture. Hardwood trees grow along the stream channels. General cash grain farming is the main farm enterprise. The main crops are corn, soybeans, grain sorghum, and wheat. The main concerns of management are the poor natural drainage and the occasional or frequent flooding. Also, measures that maintain or improve fertility and tilth are needed.

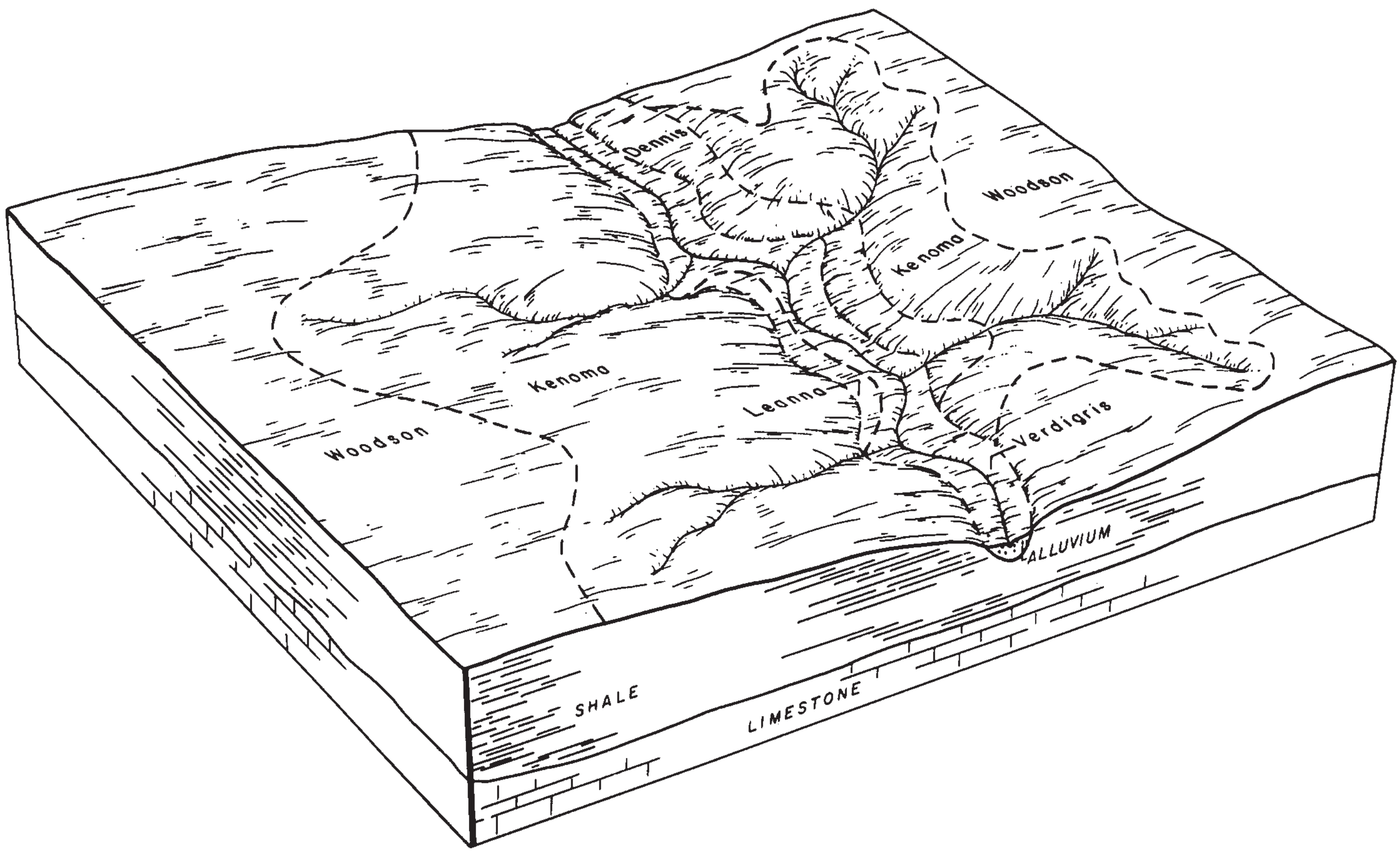

Figure 5.—Typical pattern of soils and parent material in the Kenoma-Woodson association.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Summit silty clay loam, 1 to 3 percent slopes, is one of several phases in the Summit series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Dennis-Bates complex, 2 to 6 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Bc—Bates loam, 1 to 4 percent slopes. This moderately deep, well drained, gently sloping soil is on side slopes and narrow ridgetops in the uplands. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is friable loam about 23 inches thick. It has a few sandstone fragments. It is dark brown in the upper part and yellowish brown in the lower part. Sandstone is at a depth of about 34 inches. In some places the surface layer is fine sandy loam. In other places the soil is dark to a depth of less than 7 inches. In some areas the depth to sandstone is less than 20 inches, and in other areas it is more than 40 inches.

Included with this soil in mapping are small areas of the deep Dennis and Kenoma soils, which make up about 10 percent of the unit. The moderately well drained Dennis soils are on the upper side slopes. The Kenoma soils have a very firm silty clay subsoil. They are in the less sloping areas.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. Organic matter content is moderately low. The surface layer is friable and can be easily tilled. Root penetration is restricted below a depth of about 34 inches.

About two-thirds of the acreage is used for cultivated crops. This soil is suited to soybeans, wheat, and grain sorghum. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About one-third of the acreage is used as rangeland, pasture, or hayland. This soil is well suited to those uses. About 70 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

This soil is suitable as a site for dwellings without basements. The depth to bedrock is a moderate limitation on sites for dwellings with basements, but the rock is rippable and can be excavated. Low strength is a moderate limitation on sites for local roads and streets, but strengthening or replacing the base material helps to overcome this limitation.

This soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to bedrock is a severe limitation. The deeper included soils on ridgetops and the upper side slopes are better sites for lagoons.

The capability subclass is IIe.

Bd—Bates-Collinsville loams, 3 to 7 percent slopes. These moderately sloping soils are on uplands. The moderately deep, well drained Bates soil is on the convex upper side slopes and on ridgetops. The shallow, somewhat excessively drained Collinsville soil is on convex side slopes. Individual areas are irregular in shape and range from 5 to 300 acres in size. They are 55 to 65 percent Bates soil and 20 to 30 percent Collinsville soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Bates soil has a very dark grayish brown loam surface layer about 11 inches thick. The subsoil is about 23 inches thick. It is friable loam in which the content of sandstone fragments is about 15 percent. It is dark brown in the upper part and yellowish brown in the lower part. Sandstone is at a depth of about 34 inches. In some places the surface layer is fine sandy loam. In other places the depth to sandstone is more than 40 inches. In some areas the soil is dark to a depth of less than 7 inches.

Typically, the Collinsville soil has a dark brown loam surface layer about 7 inches thick. The next 4 inches is dark brown, friable loam. The substratum is dark brown channery loam. Fine grained sandstone is at a depth of about 17 inches. In places the surface layer is fine sandy loam.

Included with these soils in mapping are small areas of Dennis, Eram, and Olpe soils, which make up about 5 to 15 percent of the unit. The Eram and Olpe soils occur as areas intermingled with areas of Bates and Collinsville soils. The moderately deep Eram soils have a very firm silty clay subsoil. The deep Olpe soils have a gravelly subsoil. The deep Dennis soils have a firm silty clay loam subsoil. They are on the lower side slopes. Also included are small eroded areas along drainageways.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and low in the Collinsville soil. Surface runoff is medium on both soils. Organic matter content is moderately low. Root penetration is restricted below a depth of about 34 inches in the Bates soil and 17 inches in the Collinsville soil.

About 40 percent of the acreage is used for cultivated crops. These soils are better suited to small grain and grain sorghum than to corn or soybeans. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About 60 percent of the acreage is used as rangeland, pasture, or hayland. These soils are well suited to those uses. About 70 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

The Bates soil is suitable as a site for dwellings without basements. The depth to bedrock is a moderate limitation if this soil is used as a site for dwellings with basements, but the rock is rippable and can be excavated. Low strength is a moderate limitation if this soil is used as a site for local roads and streets, but strengthening or replacing the base material helps to overcome this limitation. The depth to bedrock in the Collinsville soil is a severe limitation on sites for dwellings and local roads and streets.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to bedrock is a severe limitation. The deeper included soils on the lower side slopes are better sites for lagoons.

The capability subclass is IVe.

Bh—Bates-Collinsville loams, 7 to 12 percent slopes. These strongly sloping soils are on the convex upper side slopes in the uplands. The Bates soil is moderately deep and well drained. The Collinsville soil is shallow and somewhat excessively drained. It is steeper than the Bates soil. Individual areas range from 10 to 300 acres in size. They are 45 to 55 percent Bates soil and 30 to 40 percent Collinsville soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Bates soil has a very dark grayish brown loam surface layer about 11 inches thick. The subsoil is about 23 inches thick. It is friable loam in which the content of sandstone fragments is about 15 percent. It is dark brown in the upper part and yellowish brown in the lower part. Sandstone is at a depth of about 34 inches. In some places the surface layer is fine sandy loam. In other places the depth to sandstone is more than 40 inches. In some areas the soil is dark to a depth of less than 7 inches.

Typically, the Collinsville soil has a surface layer of dark brown loam about 7 inches thick. The next 4 inches is dark brown, friable loam. The substratum is dark brown, friable channery loam. Fine grained sandstone is at a depth of about 17 inches. In places the surface layer is fine sandy loam.

Included with these soils in mapping are small areas of Dennis, Eram, and Olpe soils. The deep Dennis soils have a firm clay loam subsoil. They are on the lower side slopes. The moderately deep Eram soils have a very firm silty clay subsoil. They are on the lower side slopes. The deep Olpe soils have a gravelly subsoil. They are on the upper side slopes. Also included are sandstone outcrops in the steeper areas and small eroded areas along drainageways. Included areas make up about 15 percent of the unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. Available water capacity is moderate in the Bates soil and low in the Collinsville soil. Surface runoff is rapid on both soils. Root penetration is restricted below a depth of about 34 inches in the Bates soil and 17 inches in the Collinsville soil.

Most of the acreage is used as rangeland or hayland. These soils are well suited to those uses. Most of the grassland supports native prairie grasses. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

The Bates soil is suitable as a site for dwellings without basements. The depth to bedrock is a moderate limitation if this soil is used as a site for dwellings with basements, but the rock is rippable and can be excavated. Low strength is a moderate limitation if this soil is used as a site for local roads and streets, but strengthening or replacing the base material helps to overcome this limitation. The depth to bedrock in the Collinsville soil is a severe limitation on sites for dwellings and local roads and streets.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons, mainly because the depth to bedrock is a severe limitation. The slope also is a severe limitation on sites for sewage lagoons. The deeper, less sloping included soils on the lower side slopes are better sites for lagoons.

The capability subclass is VIe.

Bo—Bolivar-Hector loams, 2 to 6 percent slopes. These moderately sloping, well drained soils are on the upper side slopes and on ridgetops in the uplands. The moderately deep Bolivar soil is on the convex upper side slopes and on ridgetops. The shallow Hector soil generally is in the steeper areas. Individual areas are irregular in shape and range from 10 to 200 acres in size. They are 55 to 65 percent Bolivar soil and 20 to 30 percent Hector soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Bolivar soil has a very dark grayish brown loam surface layer about 4 inches thick. The subsurface layer is brown, very friable loam about 9 inches thick. The subsoil is about 15 inches thick. It is dark brown, very friable loam in the upper part and brown, friable sandy clay loam in the lower part. The substratum is dark brown channery sandy clay loam. Sandstone is at a depth of about 34 inches. In some places the surface layer is fine sandy loam. In other places the depth to sandstone is more than 40 inches. In some areas the soil is dark to a depth of more than 7 inches.

Typically, the Hector soil has a dark grayish brown loam surface layer about 3 inches thick. The subsurface layer is dark brown, very friable loam about 6 inches thick. The subsoil is yellowish brown, friable loam about 9 inches thick. Fine grained sandstone is at a depth of about 18 inches. In some places the surface layer is fine sandy loam. In other places it is dark and is more than 4 inches thick.

Included with these soils in mapping are small areas of Welda soils, which make up 5 to 10 percent of the unit. These included soils are deep and have a firm silty clay loam subsoil. They are on the lower side slopes.

Permeability is moderate in the Bolivar soil and moderately rapid in the Hector soil. Available water capacity is moderate in the Bolivar soil and low in the Hector soil. Surface runoff is medium on both soils. The shrink-swell potential is moderate in the Bolivar soil.

Root penetration is restricted below a depth of about 34 inches in the Bolivar soil and 18 inches in the Hector soil.

Most of the acreage is used as rangeland. These soils are suitable as rangeland and hayland. Most of the grassland supports native prairie grasses and trees. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland.

A few areas are used as native woodland. These soils are suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Seedling mortality is a moderate limitation on the Hector soil. The mortality rate can be reduced by site preparation and by controlled burning, spraying, or cutting.

The shrink-swell potential is a moderate limitation if the Bolivar soil is used as a site for dwellings. Also, the depth to bedrock is a moderate limitation on sites for dwellings with basements, but the rock is rippable and can be excavated. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Low strength and the shrink-swell potential are moderate limitations if this soil is used as a site for local roads and streets, but strengthening or replacing the base material helps to overcome these limitations. The depth to bedrock in the Hector soil is a severe limitation on sites for dwellings and local roads and streets.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons because the depth to bedrock is a severe limitation. The deeper, less sloping included or adjacent soils are better sites for lagoons.

The capability subclass is IVe.

Bs—Bolivar-Hector loams, 6 to 12 percent slopes. These strongly sloping, well drained soils are on uplands. The moderately deep Bolivar soil is on the convex upper and lower side slopes. The shallow Hector soil generally is in the steeper areas. Individual areas are irregular in shape and range from 10 to 200 acres in size. They are 40 to 55 percent Bolivar soil and 30 to 40 percent Hector soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Bolivar soil has a very dark grayish brown loam surface layer about 4 inches thick. The subsurface layer is brown, very friable loam about 9 inches thick. The subsoil is about 15 inches thick. It is dark brown, very friable loam in the upper part and brown, friable sandy clay loam in the lower part. The substratum is dark brown channery sandy clay loam. Sandstone is at a depth of about 34 inches. In some places the surface layer is fine sandy loam. In other places the depth to sandstone is more than 40 inches. In some areas the soil is dark to a depth of more than 7 inches.

Typically, the Hector soil has a dark grayish brown loam surface layer about 3 inches thick. The subsurface layer is dark brown, very friable loam about 6 inches thick. The subsoil is yellowish brown, friable loam about 9 inches thick. Fine grained sandstone is at a depth of about 18 inches. In some places the surface layer is fine sandy loam. In other places it is dark and is more than 4 inches thick.

Included with these soils in mapping are small areas of Welda soils, which make up 5 to 10 percent of the unit. These included soils are deep and have a firm silty clay loam subsoil. They are on the lower side slopes and on foot slopes.

Permeability is moderate in the Bolivar soil and moderately rapid in the Hector soil. Available water capacity is moderate in the Bolivar soil and low in the Hector soil. Surface runoff is rapid on both soils. The shrink-swell potential is moderate in the Bolivar soil. Root penetration is restricted below a depth of about 34 inches in the Bolivar soil and 18 inches in the Hector soil.

About 90 percent of the acreage supports native prairie grasses and trees and is used as rangeland. These soils are suitable as rangeland and hayland. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain and increase the amount of forage produced on rangeland.

A few areas are used as native woodland. These soils are suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Seedling mortality is a moderate limitation on the Hector soil. The mortality rate can be reduced by site preparation and by controlled burning, spraying, or cutting.

The shrink-swell potential and the slope are moderate limitations if the Bolivar soil is used as a site for dwellings. Also, the depth to bedrock is a moderate limitation on sites for dwellings with basements, but the rock is rippable and can be excavated. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. The shrink-swell potential, low strength, and slope are moderate limitations if this soil is used as a site for local roads and streets. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and low strength. Cutting and filling generally are needed to provide a suitable grade. The depth to bedrock in the Hector soil is a severe limitation on sites for dwellings and local roads and streets.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons, mainly because the depth to bedrock is a severe limitation. The slope also is a severe limitation on sites for sewage lagoons. The deeper, less sloping included or adjacent soils are better sites for lagoons.

The capability subclass is VIe.

Cm—Clareson-Eram silty clay loams, 3 to 15 percent slopes. These moderately sloping and strongly sloping, moderately deep soils are on the convex tops and sides of ridges in the uplands. The well drained Clareson soil is on the steeper, upper side slopes. The moderately well drained Eram soil is on the lower side slopes. Individual areas are 100 to 500 feet wide and 1,000 feet to several miles long and range from 3 to 1,000 acres in size. They are 50 to 60 percent Clareson soil and 25 to 35 percent Eram soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clareson soil has a very dark brown silty clay loam surface layer about 7 inches thick. The subsoil is about 19 inches thick. It is dark brown, firm silty clay loam in the upper part and dark reddish brown, firm flaggy silty clay loam in the lower part. Limestone is at a depth of about 26 inches. In some places the surface layer is flaggy silty clay loam. In other places the lower part of the subsoil is cherty silty clay loam. In some areas the depth to limestone is more than 40 inches.

Typically, the Eram soil has a very dark brown silty clay loam surface layer about 7 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, very firm silty clay, and the lower part is coarsely mottled yellowish brown and light brownish gray, firm silty clay loam. Shale is at a depth of about 38 inches. In places the subsoil is less clayey and has shale fragments.

Included with these soils in mapping are small areas of Bates soils. These included soils are moderately deep and have a friable loam subsoil. They are on the lower side slopes. Also included, on the steeper parts of the landscape, are areas where limestone crops out. Included areas make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Clareson soil and slow in the Eram soil. Available water capacity is low in both soils. Surface runoff is medium. The shrink-swell potential is moderate in the subsoil of the Clareson soil and high in the subsoil of the Eram soil. A seasonal high water table is perched at a depth of 2 to 3 feet in the Eram soil. Root penetration is restricted below a depth of about 26 inches in the Clareson soil and 38 inches in the Eram soil.

Most of the acreage is used as rangeland or hayland. These soils are suited to those uses. Most of the grassland supports native prairie grasses. In some areas the percentage of woody vegetation is large. Growing hay is not practical in areas where the surface layer is flaggy or limestone crops out. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced in the areas used as rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

These soils generally are unsuitable as sites for dwellings with basements. On sites for dwellings without basements and local roads and streets, the large stones in the Clareson soil and the shrink-swell potential of the Eram soil are severe limitations. Also, low strength in both soils is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Strengthening or replacing the base material of the roads and streets helps to prevent the damage resulting from shrinking and swelling and from low strength.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons, mainly because the depth to bedrock is a severe limitation.

The capability subclass is VIe.

Dc—Dennis silt loam, 2 to 5 percent slopes. This deep, moderately well drained, moderately sloping soil is on the convex lower side slopes, narrow ridgetops, and terraces in the uplands. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, friable silty clay loam, the next part is olive brown and yellowish brown, firm and very firm silty clay, and the lower part is yellowish brown and olive brown, firm silty clay loam. In some places the surface layer is loam or silty clay loam. In other places the upper part of the subsoil is very firm silty clay.

Included with this soil in mapping are small areas of Bates and Woodson soils, which make up 5 to 10 percent of the unit. The moderately deep Bates soils are on the lower side slopes. The deep Woodson soils are in the less sloping areas. They have a surface layer of silt loam and a subsoil of dominantly very dark gray, very firm silty clay. The boundary between the surface layer and the subsoil is abrupt.

Permeability is slow and available water capacity high in the Dennis soil. Surface runoff is medium. Organic matter content is moderate. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 2 to 3 feet. The shrink-swell potential is high in the subsoil.

Most areas are used for cultivated crops. This soil is suited to soybeans, wheat, corn, and grain sorghum. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

This soil is well suited to pasture and hay. About 60 percent of the grassland supports cool-season tame

grasses, and the rest supports native prairie grasses. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings or local roads and streets. Also, low strength is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Strengthening or replacing the base material of local roads and streets helps to prevent the damage resulting from shrinking and swelling and low strength.

The slow permeability and the wetness are severe limitations if this soil is used as a septic tank absorption field. The slope is a moderate limitation on sites for sewage lagoons. Less sloping areas are better sites.

The capability subclass is IIIe.

Dn—Dennis-Bates complex, 2 to 6 percent slopes. These moderately sloping soils are on convex side slopes and narrow ridgetops in the uplands. The deep, moderately well drained Dennis soil is on the lower side slopes. The moderately deep, well drained Bates soil is on the steeper, upper side slopes and on ridgetops. Individual areas are irregular in shape and range from 10 to several hundred acres in size. They are 50 to 70 percent Dennis soil and 20 to 40 percent Bates soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Dennis soil has a very dark brown silt loam surface layer about 10 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, friable silty clay loam, the next part is olive brown and yellowish brown, firm and very firm silty clay, and the lower part is yellowish brown and olive brown, firm silty clay loam. In some places the surface layer is loam or silty clay loam. In other places the upper part of the subsoil is very firm silty clay.

Typically, the Bates soil has a very dark grayish brown loam surface layer about 11 inches thick. The subsoil is friable loam about 23 inches thick. It is dark brown in the upper part and yellowish brown in the lower part. Sandstone is at a depth of about 34 inches. In some places the depth to sandstone is less than 20 inches. In other places it is more than 40 inches. In some areas the soil is dark to a depth of less than 7 inches.

Included with these soils in mapping are small areas of Eram, Leanna, Olpe, and Osage soils, which make up 10 to 15 percent of the unit. The moderately deep Eram soils have a very firm silty clay subsoil. They are on the upper side slopes. The deep Leanna soils have a grayish brown subsurface layer. They are along narrow drainageways. The deep Olpe soils have a gravelly subsoil. They are on the upper side slopes. The deep Osage soils have a very firm silty clay subsoil. They are along narrow drainageways. Also included are small eroded areas along drainageways.

Permeability is slow in the Dennis soil and moderate in the Bates soil. Available water capacity is moderate in the Bates soil and high in the Dennis soil. Surface runoff is medium on both soils. The shrink-swell potential is high in the subsoil of the Dennis soil. Organic matter content is moderate in the Dennis soil and moderately low in the Bates soil. A seasonal high water table is perched at a depth of 2 to 3 feet in the Dennis soil. The surface layer of both soils is friable and can be easily tilled. Root penetration in the Bates soil is restricted below a depth of about 34 inches.

About two-thirds of the acreage is used for cultivated crops. These soils are suited to soybeans, wheat, corn, and grain sorghum. If cultivated crops are grown, erosion is a moderate hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About one-third of the acreage is used as rangeland, pasture, or hayland. These soils are well suited to those uses. About 60 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses.

Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. The amount of tame hay can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

The Bates soil is suitable as a site for dwellings without basements. Its moderate depth to bedrock is a moderate limitation on sites for dwellings with basements, but the rock is rippable and can be excavated. The shrink-swell potential of the Dennis soil is a severe limitation on sites for dwellings. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling.

The Bates soil is suitable as a site for local roads and streets, but its low strength is a moderate limitation. The low strength and shrink-swell potential of the Dennis soil are severe limitations. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and low strength.

The depth to bedrock is a severe limitation if the Bates soil is used as a site for septic tank absorption fields or sewage lagoons. The slow permeability and wetness in the Dennis soil are severe limitations in septic tank absorption fields and the slope a moderate limitation on sites for sewage lagoons. Less sloping areas are better sites for lagoons.

The capability subclass is IIIe.

Do—Dennis-Bates complex, 3 to 6 percent slopes, eroded. These moderately sloping soils are on convex side slopes on uplands dissected by many small drainageways and gullies. The deep, moderately well drained Dennis soil is in the lower side slopes. The moderately deep, well drained Bates soil is on the steeper, upper side slopes. Individual areas are irregular in shape and range from 5 to 100 acres in size. They are 50 to 65 percent Dennis soil and 25 to 40 percent Bates soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Dennis soil has a dark brown silt loam surface layer about 6 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, friable silty clay loam, the next part is olive brown and yellowish brown, firm and very firm silty clay, and the lower part is yellowish brown and olive brown, firm silty clay loam. In some places the surface layer is silty clay loam. In other places the upper part of the subsoil is very firm silty clay.

Typically, the Bates soil has a dark brown clay loam surface layer about 6 inches thick. The subsoil is friable clay loam about 24 inches thick. It is dark brown in the upper part and yellowish brown in the lower part. Sandstone is at a depth of about 30 inches. In some areas the depth to sandstone is less than 20 inches. In some places the surface layer is loam. In other places the soil is dark to a depth of less than 7 inches.

Included with these soils in mapping are small areas of Eram soils, which make up 10 to 15 percent of the unit. These included soils are moderately deep and have a very firm silty clay subsoil. They are on the upper side slopes.

Permeability is slow in the Dennis soil and moderate in the Bates soil. Available water capacity is moderate in the Bates soil and high in the Dennis soil. Surface runoff is medium on both soils. Organic matter content is moderately low. The shrink-swell potential is high in the subsoil of the Dennis soil. A seasonal high water table is perched at a depth of 2 to 3 feet in this soil. Root penetration in the Bates soil is restricted below a depth of about 30 inches.

About one-fourth of the acreage is used for cultivated crops. These soils are poorly suited to corn and soybeans. They are suited to wheat, oats, and grain sorghum. If cultivated crops are grown, further erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About three-fourths of the acreage is used as pasture or hayland. These soils are well suited to those uses. Most areas support cool-season tame grasses. A few areas support a sparse stand of weeds, woody plants, and undesirable grasses. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

The Bates soil is suitable as a site for dwellings without basements. Its moderate depth to bedrock is a moderate limitation on sites for dwellings with basements, but the rock is rippable and can be excavated. The shrink-swell potential of the Dennis soil is a severe limitation on sites for dwellings. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling.

The Bates soil is suitable as a site for local roads and streets, but its low strength is a moderate limitation. The low strength and shrink-swell potential of the Dennis soil are severe limitations. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and low strength.

The depth to bedrock is a severe limitation if the Bates soil is used as a site for septic tank absorption fields or sewage lagoons. The slow permeability and wetness in the Dennis soil are severe limitations for septic tank absorption fields, and the slope is a moderate limitation for sewage lagoons. Less sloping areas are better sites for lagoons.

The capability subclass is IVe.

Ea—Eram-Lebo silty clay loams, 7 to 12 percent slopes. These moderately deep, strongly sloping soils are on convex side slopes below limestone formations. The moderately well drained Eram soil is on the lower side slopes. The well drained Lebo soil is on the steeper, upper side slopes. Individual areas are 200 to 400 feet wide and more than 1,500 feet long and range from 7 to 100 acres in size. They are about 40 to 55 percent Eram soil and 20 to 40 percent Lebo soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Eram soil has a very dark brown silty clay loam surface layer about 7 inches thick. The subsoil is about 31 inches thick. It is very dark grayish brown, very firm silty clay in the upper part and coarsely mottled yellowish brown and light brownish gray silty clay loam in the lower part. Shale is at a depth of about 38 inches. In some areas the depth to shale is more than 40 inches.

Typically, the Lebo soil has a very dark grayish brown silty clay loam surface layer about 7 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown, friable silty clay loam in the upper part and grayish brown, friable shaly silty clay loam in the lower part. Shale is at a depth of about 28 inches. In places the surface layer is channery silty clay loam.

Included with these soils in mapping are small areas of Clareson and Dennis soils, which make up about 10 to 15 percent of the unit. The moderately deep Clareson soils have a flaggy silty clay loam subsoil. They are on the upper side slopes. The deep Dennis soils are on the lower side slopes.

Permeability is moderate in the Lebo soil and slow in the Eram soil. Available water capacity is low in both soils. Organic matter content is moderate. The shrink-swell potential is high in the subsoil of the Eram soil and moderate in the Lebo soil. Surface runoff is medium on both soils. A seasonal high water table is perched at a depth of 2 to 3 feet in the Eram soil. Root penetration is restricted below a depth of about 38 inches in the Eram soil and 28 inches in the Lebo soil.

Most of the acreage is used as rangeland, pasture, or hayland. These soils are well suited to those uses. About 75 percent of the acreage is rangeland, and the rest supports cool-season tame grasses. In some of the areas that support native grasses, a large amount of woody vegetation is part of the plant cover. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

The shrink-swell potential is a severe limitation if the Eram soil is used as a site for dwellings. Because of hillside slippage, the slope of the Lebo soil also is a severe limitation. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. The dwellings built on the Lebo soil should be designed to conform to the slope.

Low strength is a severe limitation if these soils are used as sites for local roads and streets. Also, the shrink-swell potential of the Eram soil is a severe limitation. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and from low strength.

These soils generally are unsuitable as sites for septic tank absorption fields and sewage lagoons, mainly because the depth to bedrock is a severe limitation. The slope also is a severe limitation on sites for sewage lagoons. The deeper, less sloping included or adjacent soils on the lower side slopes are better sites for lagoons.

The capability subclass is VIe.

Ec—Eram-Lula complex, 3 to 7 percent slopes. These moderately sloping soils are on convex side slopes and narrow ridgetops in the uplands. The moderately deep, moderately well drained Eram soil is on the upper side slopes. The deep, well drained Lula soil is on the less sloping mid and lower side slopes and on narrow ridgetops. Individual areas are irregular in shape and range from 10 to 150 acres in size. They are 55 to 65 percent Eram soil and 20 to 30 percent Lula soil. The two soils occur as areas so intricately mixed or so small or narrow that mapping them separately is not practical.

Typically, the Eram soil has a very dark brown silty clay loam surface layer about 7 inches thick. The subsoil is about 31 inches thick. It is very dark grayish brown, very firm silty clay in the upper part and coarsely mottled yellowish brown and light brownish gray silty clay loam in the lower part. Weathered shale is at a depth of about 38 inches. In places the subsoil is silty clay loam throughout. In some areas the depth to shale is more than 40 inches.

Typically, the Lula soil has a dark brown silt loam surface layer about 7 inches thick. The subsoil is about 37 inches thick. It is dark brown, firm silty clay loam in the upper part and dark reddish brown and reddish brown, firm and very firm silty clay loam in the lower part. Limestone is at a depth of about 44 inches. In some places the depth to limestone is less than 40 inches. In other places the surface layer is silty clay loam. In some areas the subsoil has flaggy limestone fragments.

Included with these soils in mapping are small areas of Bates, Kenoma, and Olpe soils. The moderately deep Bates soils have a friable loam subsoil. They are on the upper or mid side slopes. The deep Kenoma soils are on the less sloping upper side slopes or ridgetops. They have a surface layer of silt loam and a subsoil of very firm silty clay. The boundary between the surface layer and the subsoil is abrupt. The deep Olpe soils have a gravelly subsoil. They are on the upper side slopes. Also included are small eroded areas along drainageways and, on the steeper parts of the landscape, areas where limestone crops out. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the Lula soil and slow in the Eram soil. Available water capacity is moderate in the Lula soil and low in the Eram soil. Surface runoff is medium on both soils. Organic matter content is moderate. The shrink-swell potential is high in the subsoil of the Eram soil and moderate in the Lula soil. A

seasonal high water table is perched at a depth of 2 to 3 feet in the Eram soil. Root penetration is restricted below a depth of about 38 inches in the Eram soil and 44 inches in the Lula soil.

About half of the acreage is used for cultivated crops. These soils are better suited to small grain and grain sorghum than to corn or soybeans. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. In small areas where limestone crops out, cultivation is difficult. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About half of the acreage is used as rangeland, pasture, or hayland. These soils are well suited to those uses. About 65 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses.

Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. The amount of tame hay can be maintained or increased by timing the first cutting and selecting the cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

If these soils are used as sites for dwellings without basements, the shrink-swell potential of the Eram soil is a severe limitation and that of the Lula soil is a moderate limitation. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling.

Low strength is a severe limitation if these soils are used as sites for local roads and streets. Also, the shrink-swell potential of the Eram soil is a severe limitation. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and from low strength.

The Eram soil generally is unsuitable as a septic tank absorption field because the slow permeability, the depth to bedrock, and the wetness are severe limitations. Also, the depth to bedrock is a severe limitation on sites for sewage lagoons. The Lula soil has moderate limitations as a site for septic tank absorption fields and sewage lagoons. The moderate permeability and the depth to bedrock are limitations in septic tank absorption fields, and seepage, depth to bedrock, and slope are limitations on sites for sewage lagoons. The deeper, less sloping included or adjacent soils on ridgetops or the lower side slopes are better sites for lagoons.

The capability subclass is IVe.

Ke—Kenoma silt loam, 1 to 4 percent slopes. This deep, moderately well drained, gently sloping soil either is on the lower side slopes and ridgetops in the uplands or is on terraces. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil to a depth of about 60 inches is very firm silty clay. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is coarsely mottled reddish brown, dark brown, and brown. In some places the surface layer is silty clay loam. In other places limestone or shale is within a depth of 60 inches. In some areas the subsurface layer is grayish brown. In other areas the upper part of the subsoil is very dark gray.

Included with this soil in mapping are small areas of Lula and Olpe soils, which make up 5 to 10 percent of the unit. These soils are on ridgetops. The Lula soils are dark reddish brown in the lower part of the subsoil. The Olpe soils have a gravelly subsoil.

Permeability is very slow in the Kenoma soil, and surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate. The shrink-swell potential of the subsoil is high. The surface layer is friable and can be easily tilled.

About 70 percent of the acreage is used for cultivated crops. This soil is suited to wheat, grain sorghum, soybeans, and corn. It is better suited to wheat, grain sorghum, and soybeans than to corn. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. The very firm silty clay subsoil somewhat restricts the root zone. Also, it fails to release water readily to plants. As a result, yields are reduced during prolonged dry periods. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

About 25 percent of the acreage is used as rangeland, pasture, or hayland. This soil is well suited to those uses. About half of the grassland supports cool-season tame grasses, and half supports native prairie grasses.

Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of tame hay produced in the areas used as hayland can be maintained or increased by

timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. The amount of native hay can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings or for local roads and streets. Also, low strength is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Strengthening or replacing the base material of the roads and streets helps to prevent the damage resulting from shrinking and swelling and from low strength.

This soil generally is unsuitable as a septic tank absorption field because the very slow permeability is a severe limitation. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is IIIe.

Le—Leanna silt loam. This deep, somewhat poorly drained, nearly level soil is on flood plains and low terraces. It is occasionally flooded. Individual areas are irregular in shape and range from 10 to 150 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is grayish brown silt loam about 9 inches thick. The subsoil is about 34 inches thick. The upper part is very dark gray, firm silty clay loam, and the lower part is dark grayish brown, very firm silty clay. The substratum to a depth of about 60 inches is dark gray silty clay. In some places the thickness of the surface layer combined with that of the subsurface layer is more than 26 inches. In other places the subsoil is dark brown and less clayey.

Included with this soil in mapping are small areas of Osage soils, which make up about 5 percent of the unit. These soils do not have a grayish brown subsurface layer. They are poorly drained and are on flood plains.

Permeability is very slow in the Leanna soil, and surface runoff is slow. Available water capacity is high. Organic matter content is moderate. A seasonal high water table is perched at a depth of 0.5 to 2 feet. The surface layer is friable and can be easily tilled. The shrink-swell potential is high in the subsoil.

Most areas are used for cultivated crops. This soil is suited to soybeans, grain sorghum, corn, and wheat. The main concern of management is the excess water that runs in from the adjacent uplands. Also, the soil is wet after heavy rainfall because of the slow runoff and very slow permeability. Constructing diversions and terraces in the adjacent upland areas helps to keep water from running onto this soil. Also, drainage ditches reduce the wetness of this soil. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Ln—Lebo-Rock outcrop complex, 20 to 40 percent slopes. This map unit occurs as steep areas on the upper and mid side slopes in the uplands. The Lebo soil is well drained. It is less steep than the Rock outcrop. Individual areas are narrow and range from 10 to 200 acres in size. They are 50 to 75 percent Lebo soil and 10 to 15 percent Rock outcrop. The Lebo soil and Rock outcrop occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Lebo soil is very dark grayish brown stony silty clay loam about 7 inches thick. The subsoil is about 21 inches thick. It is dark grayish brown, friable silty clay loam in the upper part and grayish brown, friable very shaly silty clay loam in the lower part. Weathered silty shale is at a depth of about 28 inches. In places the subsoil is silty clay.

Typically, the Rock outcrop is limestone. It supports little or no vegetation. The limestone formations are generally more than 10 feet thick.

Included with the Lebo soil and Rock outcrop in mapping are small areas of Clareson soils, which make up about 5 to 10 percent of the unit. These soils are moderately deep and are on the upper side slopes.

Permeability is moderate in the Lebo soil, available water capacity is low, and surface runoff is very rapid. The shrink-swell potential is moderate. Root penetration is restricted below a depth of about 28 inches.

Most of the acreage is used as rangeland or is idle. This map unit is suitable as rangeland. It supports native prairie grasses and woody vegetation. In many areas at least 50 percent of the canopy is woody vegetation. Proper stocking rates, timely deferment of grazing, and

control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland.

This map unit generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the slope is a severe limitation.

The capability subclass is VIIe.

Lo—Lula silt loam, 0 to 2 percent slopes. This deep, well drained, nearly level soil is on ridgetops above areas where limestone crops out. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil is about 37 inches thick. It is dark brown, firm silty clay loam in the upper part, dark reddish brown, firm silty clay loam in the next part, and dark reddish brown and reddish brown, very firm silty clay loam in the lower part. Limestone is at a depth of about 44 inches. In some places the surface layer is silty clay loam. In other places the depth to limestone is less than 40 inches. In some areas the subsoil is flaggy silty clay loam. In other areas the subsoil is cherty or gravelly clay loam.

Included with this soil in mapping are small areas of Kenoma, Summit, and Woodson soils, which make up 5 to 10 percent of the unit. The deep Kenoma and Woodson soils have a very firm silty clay subsoil. They are in positions on the landscape similar to those of the Lula soil. The deep Summit soils are very dark gray in the upper part of the subsoil. They are on the lower side slopes.

Permeability and available water capacity are moderate in the Lula soil. Surface runoff is slow. Organic matter content is moderate. The shrink-swell potential also is moderate. The surface layer is friable and can be easily tilled. Root penetration is restricted below a depth of about 44 inches.

Most areas are used for cultivated crops. This soil is well suited to soybeans, wheat, grain sorghum, and corn. A cropping system that results in the most efficient use of the amount of available water is the main management need. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas are used as rangeland, pasture, or hayland. This soil is well suited to those uses. About half of the grassland supports cool-season tame grasses, and half supports native prairie grasses.

Proper stocking rates, rotation grazing, well distributed watering and salting facilities, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of tame hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. The amount of native hay can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Also, the depth to bedrock is a moderate limitation on sites for dwellings with basements. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The depth to bedrock is a moderate limitation if this soil is used as a site for septic tank absorption fields or sewage lagoons. Also, the moderate permeability is a moderate limitation in septic tank absorption fields and seepage a moderate limitation on sites for sewage lagoons. The moderate permeability can be overcome by increasing the size of the absorption field or by installing two absorption fields that are used alternately. Sealing the lagoon helps to prevent seepage. The deeper included soils on the lower side slopes are better sites for lagoons.

The capability class is I.

Mb—Mason silt loam. This nearly level, well drained soil is on terraces. It is subject to rare flooding of short duration. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark brown silty clay loam about 7 inches thick. The subsoil is silty clay loam about 38 inches thick. The upper part is very dark grayish brown and friable, and the lower part is dark brown and firm. The substratum to a depth of about 60 inches is brown silty clay loam. In places the surface layer is more than 7 inches thick.

Included with this soil in mapping are small areas of Osage and Welda soils, which make up 5 to 10 percent of the unit. The poorly drained Osage soils are in the concave lower areas. They have a very firm silty clay subsoil. The well drained Welda soils are in positions on the landscape similar to those of the Mason soil. They have a brown subsurface layer.

Permeability is moderately slow in the Mason soil, and surface runoff is slow. Available water capacity is high. The shrink-swell potential is moderate. Organic matter content also is moderate. The surface layer is friable and can be easily tilled.

Most areas are used for cultivated crops. This soil is well suited to soybeans, corn, wheat, and grain sorghum.

The main management needs are measures that improve fertility and tilth. Minimum tillage, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

A few areas support native hardwoods. This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. Plant competition can be controlled by site preparation and by controlled burning, spraying, or cutting. No hazards or limitations affect planting and harvesting.

The flooding is a severe hazard if this soil is used as a site for dwellings. Dikes, levees, or other structures that control floodwater are needed. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The moderately slow permeability is a severe limitation if this soil is used as a septic tank absorption field. Increasing the size of the absorption field or installing two absorption fields that are used alternately helps to overcome this limitation. The soil is suitable as a site for sewage lagoons.

The capability class is I.

Oe—Olpe-Kenoma complex, 1 to 5 percent slopes. These moderately sloping soils are on side slopes and narrow ridgetops in the uplands. The Olpe soil is well drained and the Kenoma soil moderately well drained. Individual areas are irregular in shape and range from 5 to 60 acres in size. They are 55 to 65 percent Olpe soil and 25 to 35 percent Kenoma soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Olpe soil has a very dark grayish brown silty clay loam surface layer about 10 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is very dark grayish brown, firm silty clay loam that has a few pebbles. The next part is dark brown, very firm very gravelly clay loam. The lower part is reddish brown and coarsely mottled brown, dark gray, and reddish brown, very firm very gravelly clay. In some places the surface layer is gravelly silt loam. In other places the subsoil is flaggy silty clay loam.

Typically, the Kenoma soil has a very dark brown silt loam surface layer about 5 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil to a depth of about 60 inches is very firm silty clay. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is coarsely mottled reddish brown, dark brown, and brown. In some places limestone or shale is within a depth of 60 inches. In other places the upper part of the subsoil is silty clay loam.

Included with these soils in mapping are small areas of Bates, Eram, and Lula soils, which make up 10 to 15 percent of the unit. The moderately deep Bates soils have a friable loam subsoil. They are on the lower side slopes. The Eram soils are underlain by shale within a depth of 40 inches. They are on the lower side slopes. The deep Lula soils have dark brown, firm silty clay loam in the upper part of the subsoil. They are on the ridgetops.

Permeability is very slow in the Kenoma soil and slow in the Olpe soil. Available water capacity is moderate in both soils. Surface runoff is medium. Organic matter content is moderate. The shrink-swell potential is high in the subsoil of the Kenoma soil and moderate in the Olpe soil.

Only a few areas are cultivated. These soils are poorly suited to many cultivated crops but are suited to wheat, grain sorghum, and soybeans. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commerical fertilizer increase the organic matter content and improve fertility and tilth. Cultivation is difficult in the gravelly areas.

Most of the acreage is used as rangeland, pasture, or hayland. These soils are well suited to those uses. About two-thirds of the grassland supports native prairie grasses. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition.

If these soils are used as sites for dwellings or for local roads and streets, the shrink-swell potential of the Olpe soil is a moderate limitation and that of the Kenoma soil is a severe limitation. Also, low strength is a severe limitation if the Kenoma soil is used as a site for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Strengthening or replacing the base material of the roads and streets helps to prevent the damage resulting from shrinking and swelling and from low strength.

These soils generally are unsuitable as septic tank absorption fields because the slow or very slow

permeability is a severe limitation. The slope of both soils and seepage in the Olpe soil are moderate limitations on sites for sewage lagoons. The less sloping areas are the better sites. Sealing the lagoon helps to prevent seepage.

The capability subclass is IVe.

Os—Osage silty clay loam. This deep, poorly drained, nearly level soil is on flood plains. It is occasionally flooded. Slopes are concave in places. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is about 42 inches thick. The upper part is very dark gray, firm silty clay loam, and the lower part is very dark gray, very firm silty clay. The substratum to a depth of about 60 inches is dark grayish brown silty clay. In places the surface layer is silt loam or silty clay.

Included with this soil in mapping are small areas of Leanna, Mason, and Verdigris soils, which make up 10 to 15 percent of the unit. The Leanna soils have a light colored subsurface layer. They are in positions on the landscape similar to those of the Osage soil. The well drained Mason soils are in the higher lying areas. The well drained Verdigris soils are nearer to streams than the Osage soil.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. Organic matter content also is moderate. The surface layer is friable and can be easily tilled. A seasonal high water table is perched within a depth of 1 foot. The shrink-swell potential is very high in the subsoil.

Most areas are used for cultivated crops. This soil is suited to soybeans, corn, grain sorghum, and wheat. The main concern of management is the excess water that runs in from the adjacent uplands. Also, the soil is wet after heavy rainfall because of the very slow runoff and permeability. Constructing diversions and terraces in the adjacent upland areas helps to keep water from running onto this soil. Also, drainage ditches and land grading reduce the wetness of this soil. Leaving crop residue on the surface increases the infiltration rate. Minimum tillage and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

A few areas are used as native woodland. This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Because of the wetness, the equipment limitation is moderate and seedling mortality and plant competition are severe. Equipment is more easily used if the trees are harvested in fall and winter, when the amount of precipitation is generally lower. Site preparation and controlled burning, spraying, or cutting reduce the rate of seedling mortality and control plant competition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Ov—Osage silty clay. This deep, nearly level, poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface soil is very dark gray silty clay about 17 inches thick. The subsoil is very dark gray, very firm silty clay about 33 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay. In places the surface soil is silty clay loam.

Included with this soil in mapping are small areas of Verdigris soils, which make up about 10 percent of the unit. These soils have a friable silt loam surface layer. They are nearer to streams than the Osage soil.

Permeability is very slow in the Osage soil. Surface runoff also is very slow. Available water capacity is moderate. Organic matter content also is moderate. The shrink-swell potential is very high. The surface layer is plastic and sticky when wet and very hard when dry. As a result, cultivation is difficult. A seasonal high water table is perched within a depth of 1 foot.

Most of the acreage is used for cultivated crops. This soil is suited to wheat, grain sorghum, soybeans, and corn. It is better suited to wheat, grain sorghum, and soybeans than to corn. The main concern of management is the excess water. The soil is wet after heavy rainfall because of the very slow runoff and permeability. The clayey subsoil fails to release water readily to plants. As a result, yields are reduced during dry periods. A bedding system and drainage ditches reduce the wetness. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

Some areas support cool-season tame grasses. This soil is suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The

amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

A few areas are used as native woodland. This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled. Because of the wetness, the equipment limitation is moderate and seedling mortality and plant competition are severe. Equipment is more easily used if the trees are harvested in fall and winter, when the amount of precipitation is generally lower. Site preparation and controlled burning, spraying, or cutting reduce the rate of seedling mortality and control plant competition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Pt—Pits, quarries. This map unit occurs as areas from which the soil and much of the underlying limestone or shale have been removed. The underlying material has been used as a source of gravel or limestone. The quarries generally are surrounded by vertical walls. Some are filled with water. Most support no plants, but some support scattered trees, shrubs, and clumps of grass. Pits, quarries, have good potential for the development of upland wildlife habitat, fishing areas, and other recreation areas.

This map unit is not assigned to a capability class or subclass.

Sn—Summit silty clay loam, 1 to 3 percent slopes. This deep, moderately well drained, gently sloping soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is about 51 inches thick. The upper part is very dark gray, firm silty clay loam, the next part is very dark grayish brown, very firm silty clay, and the lower part is dark grayish brown, very firm silty clay. The substratum to a depth of about 60 inches is dark brown silty clay loam. In some places the surface layer is more than 6 inches thick. In other places it is silt loam. In some areas the upper part of the subsoil is very firm silty clay.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. The shrink-swell potential is high. Organic matter content is moderate. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 2 to 3 feet.

Most areas are used for cultivated crops. This soil is well suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and from low strength.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is IIe.

So—Summit silty clay loam, 3 to 7 percent slopes. This deep, moderately well drained, moderately sloping soil is on convex side slopes, generally below areas where limestone crops out. Individual areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil is about 51 inches thick. The upper part is very dark gray, firm silty clay loam, the next part is very dark grayish brown, very firm silty clay, and the lower part is dark grayish brown, very firm silty clay. The substratum to a depth of about 60 inches is dark brown silty clay loam. In some places, particularly along drainageways, the surface layer is silty clay. In other places the depth to shale is less than 40 inches. In some areas, the surface layer is loam or silt loam and the upper part of the subsoil is clay loam. In other areas, the surface layer is silt loam and the upper part of the subsoil is very firm silty clay.

Included with this soil in mapping are small areas of Clareson, Lebo, and Lula soils, which make up about 5 to 10 percent of the unit. The moderately deep Clareson soils have a flaggy silty clay loam subsoil. They are on the upper side slopes. The moderately deep Lebo soils have a friable silty clay loam subsoil. They are on the upper side slopes. The deep Lula soils are dark brown in the upper part of the subsoil. They are on the lower side slopes.

Permeability is slow in the Summit soil, and surface runoff is medium. Available water capacity is moderate. The shrink-swell potential is high in the subsoil. Organic matter content is moderate. The surface layer is friable and can be tilled easily. A seasonal high water table is perched at a depth of 2 to 3 feet.

About 60 percent of the acreage is used for cultivated crops. This soil is suited to soybeans, wheat, grain sorghum, and corn. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

About 40 percent of the acreage is used as rangeland, pasture, or hayland. This soil is well suited to those uses. About two-thirds of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses.

Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. The amount of tame hay can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the forage produced on tame pasture.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to prevent the damage resulting from shrinking and swelling and from low strength.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. Less sloping areas are better sites.

The capability subclass is IIIe.

Vb—Verdigris silt loam. This deep, nearly level, well drained soil is on flood plains. It is occasionally flooded for very brief periods. Individual areas are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark brown silt loam about 9 inches thick. The next 12 inches is very dark grayish brown, friable silty clay loam. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam. In some places the material below the subsurface layer is silt loam. In other places grayish brown mottles are below a depth of about 16 inches. In some areas the surface layer is silty clay loam or loam.

Included with this soil in mapping are small areas of Leanna, Mason, and Osage soils, which make up 10 to 15 percent of the unit. The somewhat poorly drained Leanna soils are in concave areas. They have a very dark gray silty clay subsoil. The Mason soils have a silty clay loam subsoil. They are on terraces. The poorly drained Osage soils are in concave areas. They have a silty clay subsoil.

Permeability is moderate in the Verdigris soil, and surface runoff is slow. Available water capacity is high. Organic matter content is moderate. The shrink-swell potential also is moderate. The surface layer is friable and can be easily tilled.

Most of the acreage is used for cultivated crops (fig. 6). This soil is well suited to corn, soybeans, grain sorghum, and wheat. Flooding, fertility, and tilth are the main management concerns. The flooding generally cannot be controlled but seldom causes serious crop damage. Minimum tillage, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Vc—Verdigris silt loam, channeled. This deep, well drained, nearly level soil is along drainageways on uplands that are dissected by meandering channels (fig. 7). It is frequently flooded. Individual areas are 150 to 400 feet wide and range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark brown silt loam about 9 inches thick. The next 12 inches is very dark grayish brown, friable silty clay loam.

Figure 6.—Newly planted grain sorghum on Verdigris silt loam.

The substratum to a depth of about 60 inches is dark grayish brown silty clay loam.

Included with this soil in mapping are small areas of Bates, Dennis, Eram, Leanna, Osage, and Summit soils, which make up 10 to 15 percent of the unit. The moderately deep Bates soils have a loamy subsoil. They are on the short side slopes. The deep Dennis and Summit soils and the moderately deep Eram soils have a clayey subsoil. They are on the short side slopes. The poorly drained Osage soils are in concave areas. They have a very dark gray subsoil. The somewhat poorly drained Leanna soils are in positions on the landscape similar to those of the Verdigris soil. They have a grayish brown subsurface layer. Also included is Rock outcrop on short, steep slopes.

Permeability is moderate in the Verdigris soil, and surface runoff is slow. Available water capacity is high. Organic matter content is moderate. The shrink-swell potential also is moderate.

A few areas are cultivated. This soil generally is not suited to cultivated crops, however, because of the frequent flooding and the inaccessibility. Farm ponds commonly are built in areas of this soil.

Most of the acreage is used as rangeland, pasture, or hayland. This soil is well suited to those uses. About 60 percent of the grassland supports native prairie grasses, and the rest supports cool-season tame grasses.

Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland. The amount of native hay produced in the areas used as hayland can be maintained or increased by mowing when the dominant species reaches the boot stage, by

selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. The amount of tame hay can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture.

A few areas are used as native woodland. This soil is suited to trees, but plant competition is moderate. Tree seeds, cuttings, and seedlings can survive and grow well only if competing plants are controlled by site preparation and by controlled burning, spraying, or cutting.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is Vw.

Wb—Welda silt loam, 2 to 6 percent slopes. This deep, well drained, moderately sloping soil either is on the convex lower side slopes in the uplands or is on terraces. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is brown, friable silt loam about 5 inches thick. The subsoil is about 39 inches thick. It is dark brown, firm silty clay loam in the upper part, dark brown, very firm silty clay in the next part, and dark yellowish brown, very firm silty clay in the lower part. The substratum to a depth of

Figure 7.—Trees along a meandering drainageway in an area of Verdigris silt loam, channeled.

about 60 inches is dark grayish brown and brown silty clay loam. In some places limestone is within a depth of 60 inches. In other places the slope is less than 2 percent. In some areas the surface layer is loam. In other areas the soil is dark to a depth of more than 10 inches.

Included with the soil in mapping are small areas of Bolivar and Mason soils, which make up 5 to 10 percent of the unit. The moderately deep Bolivar soils have very friable loam in the upper part of the subsoil. They are on the upper side slopes. The deep Mason soils do not have a brown subsurface layer. They are on terraces.

Permeability is moderately slow and available water capacity high in the Welda soil. Surface runoff is medium. Organic matter content is low. The shrink-swell potential is moderate. The surface layer is very friable and can be easily tilled.

Most areas are cultivated. This soil is suited to soybeans, wheat, corn, and grain sorghum. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, and grassed waterways. Minimum tillage, crop rotation, a cover of crop residue, and applications of commercial fertilizer increase the organic matter content and improve fertility and tilth.

Some areas support cool-season tame grasses. A few areas have a cover of woody vegetation but are used as pasture. This soil is well suited to pasture and hay. Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

A few areas are used as native woodland. This soil is suited to trees. No limitations affect planting or harvesting.

The shrink-swell potential is a moderate limitation if this soil is used as a site for dwellings. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to prevent the damage resulting from low strength.

The moderately slow permeability is a severe limitation if this soil is used as a septic tank absorption field. Increasing the size of the absorption field or installing two absorption fields that are used alternately helps to overcome this limitation. Slope and seepage are moderate limitations on sites for sewage lagoons. Less sloping areas are better sites. Sealing the lagoon helps to prevent seepage.

The capability subclass is IIe.

Wo—Woodson silt loam, 0 to 1 percent slopes. This deep, somewhat poorly drained, nearly level soil is on broad ridgetops in the uplands and on high terraces. Individual areas are irregular in shape and range from 20 to 500 acres in size.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 31 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is coarsely mottled yellowish brown and gray silty clay loam. In some places the upper part of the subsoil is very dark grayish brown or dark brown. In other places the subsurface layer is grayish brown.

Permeability is very slow, and surface runoff is slow. Available water capacity is moderate. The shrink-swell potential is high in the subsoil. Organic matter content is moderate. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 0.5 to 2.0 feet.

Most of the acreage is used for cultivated crops. This soil is suited to soybeans, wheat, grain sorghum, and corn. It is better suited to wheat, grain sorghum, and soybeans than to corn. The main concerns of management are tilth and the organic matter content. Also, the soil is wet after heavy rainfall because of the slow runoff and very slow permeability. The very firm silty clay subsoil somewhat restricts the root zone. Also, it fails to release water readily to plants. As a result, yields are reduced during dry periods. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

The shrink-swell potential and the seasonal high water table are severe limitations if this soil is used as a site for dwellings or for local roads and streets. Also, low strength is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Strengthening or replacing the base material of local roads and streets helps to prevent the damage resulting from low strength and from shrinking and swelling. Also, installing a drainage system reduces the wetness.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Ws—Woodson silt loam, 1 to 2 percent slopes. This deep, gently sloping, somewhat poorly drained soil is on broad ridgetops. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray, friable silt loam about 5 inches thick. The subsoil is very firm silty clay about 31 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown. The substratum to a depth of about 60 inches is coarsely mottled yellowish brown and gray silty clay loam. In some places the substratum is silty clay. In other places the upper part of the subsoil is very dark grayish brown or dark brown. In some areas the depth to the silty clay subsoil is more than 15 inches. In other areas the subsurface layer is grayish brown. The surface soil is silty clay loam in areas where it has been mixed with the upper part of the subsoil.

Permeability is very slow, and surface runoff is medium. Available water capacity is moderate. Organic matter content also is moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of about 0.5 to 2.0 feet.

About 75 percent of the acreage is used for cultivated crops. This soil is suited to soybeans, wheat, grain sorghum, and corn. It is better suited to wheat, grain sorghum, and soybeans than to corn. If cultivated crops are grown, erosion is a hazard. It can be controlled by terraces, contour farming, grassed waterways, minimum tillage, and a cover of crop residue. The very firm silty clay subsoil somewhat restricts the root zone. Also, it fails to release water readily to plants. As a result, yields are reduced during dry periods. Minimum tillage, a cover of crop residue, and timely applications of commercial fertilizer increase the organic matter content and improve fertility and tilth. In some years fall tillage is needed to prepare a desirable seedbed for the crops planted early in the next growing season.

About 25 percent of the acreage is used as rangeland, pasture, or hayland. This soil is well suited to those uses. About half of the grassland supports cool-season tame grasses, and half supports native prairie grasses.

Proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation help to maintain or increase the amount of forage produced on tame pasture. The amount of tame hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer. The amount of native hay can be maintained or increased by mowing when the dominant species reaches the boot stage, by selecting a cutting height of more than 4 inches, by applying measures that prevent grazing, and by deferring cutting as needed to increase plant vigor and improve plant composition. Proper stocking rates, timely deferment of grazing, and control of unwanted vegetation help to maintain or increase the amount of forage produced on rangeland.

The shrink-swell potential and the seasonal high water table are severe limitations if this soil is used as a site for dwellings or for local roads and streets. Also, low strength is a severe limitation on sites for local roads and streets. Installing reinforced foundations below the depth of seasonal drying and providing foundation drains help to prevent the damage to buildings caused by shrinking and swelling and by wetness. Strengthening or replacing the base material of local roads and streets helps to prevent the damage resulting from low strength and from shrinking and swelling. Also, installing a drainage system reduces the wetness.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIIe.

prime farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is of major importance in providing the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for producing food or fiber or is available for these uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil ecomonically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 7 percent. More detailed information about the criteria for prime farmland is available at local offices of the Soil Conservation Service.

About 265,000 acres in Franklin County, or nearly 72 percent of the total acreage, meets the requirements for prime farmland. This acreage occurs as areas throughout the county. About 225,000 acres of this prime farmland is cropped. The crops grown on this land, mainly soybeans, grain sorghum, wheat, and corn, account for an estimated seven-eighths of the county's total crop income each year.

The map units considered prime farmland in the county are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 200,000 acres in Franklin County is cropland, and about 40,000 acres is pasture or hayland. About 75 percent of the cropland was used for harvested crops during the period 1967 to 1977. This compares with 78 percent during the period 1957 to 1967.

During the period 1969 to 1979, soybeans were grown on about 34 percent of the acreage used for crops, pasture, and hay; grain sorghum on 20 percent; corn on 18 percent; wheat on 18 percent; and alfalfa and other crops on 10 percent. The acreage planted to soybeans and grain sorghum has increased in recent years, whereas the acreage planted to the other crops has decreased or remained constant.

The productivity of the soils used for crops and pasture can be increased on most farms by applying the latest crop production technology. This soil survey can help facilitate the application of such technology. A good system of soil management is needed. The main management needs are measures that help to control erosion, improve fertility and tilth, and result in the most efficient use of the amount of water in the soil that is available to plants.

The crops commonly grown in the county respond well to applications of nitrogen, phosphate, and, in some areas, potash. The surface layer of most of the soils is medium acid or slightly acid unless ground limestone has been applied in recent years. On all of the soils, the kinds and amounts of fertilizer and lime applied should be based on the needs of the crop, on the expected level of yields, on the results of soil tests, and on the knowledge gained by previous experience. The Cooperative Extension Service can help to determine the kinds and amounts needed.

Soil erosion is the major concern if the soils are cropped year after year. It is a hazard if the slope is more than 1 percent. Most of the upland soils in the county have a slope of 2 percent or more.

Any loss of soil material from the surface layer also results in the loss of natural and applied available plant nutrients and of organic matter. If the losses are large,

yields are reduced, seedbed preparation and tilling are more difficult, and nearby streams can be polluted by sediment, plant nutrients, and pesticides. Excessive losses are especially damaging on Kenoma, Summit, Woodson, and other soils that have a clayey subsoil and on soils having a layer that limits the depth of the root zone. Examples of this kind of layer are the shale underlying Eram and Lebo soils and the bedrock underlying Bates, Clareson, and Collinsville soils.

Erosion can be effectively controlled by terraces, contour farming, grassed waterways, a cover of crop residue, timely tillage, and minimum tillage. Terraces, contour farming, and grassed waterways help to control erosion and conserve moisture on Dennis, Kenoma, and Summit soils. Alone or in combination, they also are beneficial on nearly level soils that have long slopes.

A cover of crop residue is beneficial on all of the soils. It not only helps to control erosion but also helps to prevent puddling during rainfall, improves tilth, and increases the organic matter content and the rate of water infiltration.

The organic matter content affects the fertility of soils through its effect on the content of available plant nutrients, particularly nitrogen and minor nutrients. It can be increased by returning all available crop residue to the soil and by applying barnyard manure.

Soil tilth is a concern on all of the soils in the county, particularly Osage soils. It affects the rate of water infiltration and the ease with which a seedbed can be prepared. Soils with good tilth are granular and porous.

Drainage of excess surface water is needed on about 10 percent of the acreage used for crops, especially on Leanna and Osage soils. Surface drains or a bedding system helps to remove the excess water.

If the soils are seeded to tame grasses, measures that maintain or improve the quality and quantity of forage, protect the soil against erosion, and reduce water losses are the main management needs. Examples are proper stocking rates, rotation grazing, well distributed watering and salting facilities, applications of fertilizer, and control of unwanted vegetation. The amount of tame hay produced in the areas used as hayland can be maintained or increased by timing the first cutting and selecting a cutting height according to the species grown and by applying the most economical kinds and amounts of fertilizer.

Further information about managing the soils for crops and tame grasses can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Lynn Gibson, range conservationist, Soil Conservation Service, helped prepare this section.

About 25 percent of the acreage in Franklin County is classified as rangeland, based on the kinds and amounts of plants. Other areas that support trees and an understory of grasses are grazed by livestock and have good potential for the plants used as forage. Range plants provide a significant amount of forage during the summer, when their protein and food value are high, but only a few ranchers depend entirely on native grasses to feed livestock. Tame pasture and crop residue supplement the forage grown on rangeland.

Most of the rangeland is in the western part of the county (fig. 8), near Pamona and Williamsburg. Some small tracts, generally less than 100 acres in size, are in the other parts of the county. On most of the smaller tracts, the rangeland has been greatly depleted because of poor management, which has resulted in the invasion of brush, scrub trees, and weeds. The amount of forage produced on these tracts generally is less than half of that originally produced. Bates, Clareson, Collinsville, Eram, and Lebo soils are the dominant soils in many depleted areas. If well managed, these soils can produce a large amount of high quality forage.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for many soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential

Figure 8.—Native grass pasture in an area of the Dennis-Bates-Woodson association in the west-central part of the county.

community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

woodland management and productivity

About 9 percent of the acreage in Franklin County is classified as woodland. Only a small part of this acreage, however, is managed for commercial trees. A few trees are cut for fuel or for fenceposts. Some nuts are harvested from pecan and walnut trees. An estimated 95 percent of the woodland is grazed by livestock.

About 70 percent of the woodland is on uplands, and the rest is on the bottom land along streams. The soils on the uplands support mainly hickory, oak, elm, ash, and osageorange and an understory of little bluestem and big bluestem. The soils on the bottom land support mainly ash, cottonwood, elm, sycamore, bur oak, soft maple, pecan, black walnut, hackberry, hickory, and boxelder. They have good potential for commercial trees (fig. 9).

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted

root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe* more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where

Figure 9.—Logs harvested on Verdigris silt loam.

there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Franklin County has several areas of scenic, geologic, and historic interest. The many farm ponds and the Marais Des Cygnes River and its tributaries provide a few opportunities for water sports. Several large reservoirs on public lands in nearby counties provide opportunities for recreation.

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The

best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Franklin County are bobwhite quail, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl. Furbearers are common along the Marias Des Cygnes River and its tributaries. They are trapped on a limited basis.

Nongame species are numerous because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each of these types provides a habitat for a particular group of species.

Ponds and streams provide good to excellent fishing. Species commonly caught are bass, bluegill, crappie, carp, channel cat, bullhead, and flathead catfish.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, grain sorghum, soybeans, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestems, switchgrass, indiangrass, goldenrod, ragweed, sunflowers, wheatgrass, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, sycamore, cottonwood, black walnut, hackberry, green ash, elm, mulberry, and hickory. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, winterberry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are redcedar, pine, and spruce.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface

stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite, mourning dove, meadowlark, field sparrow, cottontail rabbit, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbirds, muskrat, mink, and beaver.

Technical assistance in planning wildlife areas and in determining the vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from local offices of the Kansas Fish and Game Commission and the Cooperative Extension Service.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging,

filling, and compacting is affected by the depth to bedrock or a dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

sanitary facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on

the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such

properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large

stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments more than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil

blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 17, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than

that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 19, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, thermic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and interbedded loamy shale. Slope ranges from 1 to 8 percent.

Bates soils are similar to Bolivar and Collinsville soils and are commonly adjacent to Collinsville, Dennis, and Kenoma soils. Bolivar soils lack a mollic epipedon. Their position on the landscape is similar to that of the Bates soils. Collinsville soils are less than 20 inches deep over bedrock. They are on the steeper side slopes. Dennis and Kenoma soils have a clayey subsoil. Dennis soils

are lower on the landscape than the Bates soils, and Kenoma soils are higher.

Typical pedon of Bates loam, 1 to 4 percent slopes, 500 feet south and 100 feet east of the northwest corner of sec. 30, T. 17 S., R. 19 E.

A1—0 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine and fine and few medium roots; common worm casts; less than 5 percent small sandstone fragments; medium acid; gradual smooth boundary.

B1—11 to 19 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine and fine and few medium roots; common worm casts; less than 5 percent small sandstone fragments; medium acid; gradual smooth boundary.

B2t—19 to 26 inches; dark brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable; common very fine and fine roots; common worm casts; less than 5 percent small sandstone fragments; medium acid; gradual smooth boundary.

B3—26 to 34 inches; yellowish brown (10YR 5/4) loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable; about 10 percent small sandstone fragments; medium acid; abrupt wavy boundary.

Cr—34 inches; soft fine grained sandstone.

The solum ranges from 20 to 40 inches in thickness. It is slightly acid or medium acid. The thickness of the mollic epipedon ranges from 8 to 20 inches.

The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is dominantly loam, but the range includes fine sandy loam and clay loam. The B horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is loam or clay loam; it averages as low as 23 percent clay in some pedons and as high as 35 percent clay in others.

Bolivar series

The Bolivar series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and interbedded loamy shale. Slope ranges from 2 to 12 percent.

Bolivar soils are similar to Bates and Hector soils and are commonly adjacent to Bates, Hector, and Welda soils. Bates soils have a mollic epipedon. They are in positions on the landscape similar to those of the Bolivar soils. Hector soils are less than 20 inches deep over bedrock. They are on the steeper side slopes. Welda soils have a clayey subsoil. They are lower on the landscape than the Bolivar soils.

Typical pedon of Bolivar loam, in an area of Bolivar-Hector loams, 2 to 6 percent slopes, 175 feet west and 225 feet south of the northeast corner of sec. 13, T. 17 S., R. 18 E.

O1—1/2 inch to 0; partly decomposed vegetative matter.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; medium acid; gradual smooth boundary.

A2—4 to 13 inches; brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; medium acid; gradual smooth boundary.

B1—13 to 21 inches; dark brown (10YR 4/3) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, very friable; many very fine and fine and common medium and coarse roots; strongly acid; gradual smooth boundary.

B2t—21 to 28 inches; brown (7.5YR 5/4) sandy clay loam, pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; hard, friable; many very fine and fine and common medium and coarse roots; some old root channels or wormholes coated with dark films and stains; less than 5 percent small sandstone fragments; strongly acid; gradual wavy boundary.

C—28 to 34 inches; dark brown (7.5YR 4/4) channery sandy clay loam, brown (7.5YR 5/4) dry; massive; hard, friable; common very fine and fine and few medium and coarse roots; strongly acid; abrupt irregular boundary.

Cr—34 inches; soft fine grained sandstone.

The depth to sandstone or shale is 20 to 40 inches and coincides with the thickness of the solum. Sandstone fragments are in all horizons in some pedons. The A1 horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is dominantly loam, but the range includes fine sandy loam. The B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is loam, sandy clay loam, or clay loam. It is medium acid or strongly acid.

Clareson series

The Clareson series consists of moderately deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 3 to 15 percent.

Clareson soils are similar to Lula and Olpe soils and are commonly adjacent to Eram, Lebo, Lula, and Olpe soils. Lula and Olpe soils have a solum that is more than 40 inches thick. They are higher on the landscape than the Clareson soils. Eram and Lebo soils are lower on the landscape than the Clareson soils. Eram soils have a

clayey subsoil that has few or no coarse fragments. Lebo soils lack an argillic horizon.

Typical pedon of Clareson silty clay loam, in an area of Clareson-Eram silty clay loams, 3 to 15 percent slopes, 1,200 feet west and 200 feet south of the northeast corner of sec. 13, T. 18 S., R. 17 E.

A1—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; many very fine and fine and common medium roots; slightly acid; gradual smooth boundary.

B1—7 to 15 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; strong medium granular structure; hard, firm; many very fine and fine and few medium roots; neutral; gradual wavy boundary.

B2t—15 to 26 inches; dark reddish brown (5YR 3/3) flaggy silty clay loam, reddish brown (5YR 4/4) dry; moderate fine and medium subangular blocky structure; very hard, firm; common very fine and few fine roots; few black stains on faces of some peds; about 60 percent flaggy limestone fragments; neutral; abrupt irregular boundary.

R—26 inches; hard limestone.

The solum ranges from 20 to 40 inches in thickness. The depth to the B2t horizon is less than 20 inches. The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is dominantly silty clay loam, but the range includes flaggy silty clay loam. The B2t horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 or 4, and chroma of 3 to 5. It is silty clay or silty clay loam in which the content of limestone fragments is 35 to 85 percent. The limestone fragments are dominantly flagstones.

Collinsville series

The Collinsville series consists of shallow, somewhat excessively drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 3 to 12 percent.

Collinsville soils are similar to Bates and Hector soils and are commonly adjacent to Bates and Bolivar soils. Bates and Bolivar soils have an argillic horizon and are 20 to 40 inches deep over bedrock. They are in the less sloping areas. Hector soils lack a mollic epipedon. They are in positions on the landscape similar to those of the Collinsville soils.

Typical pedon of Collinsville loam, in an area of Bates-Collinsville loams, 7 to 12 percent slopes, 400 feet north and 1,850 feet east of the southwest corner of sec. 19, T. 17 S., R. 19 E.

A1—0 to 7 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; medium acid; gradual smooth boundary.

AC—7 to 11 inches; dark brown (7.5YR 4/4) loam, brown (7.5YR 5/4) dry; weak medium granular structure; slightly hard, friable; many very fine and fine and common medium roots; about 15 percent small sandstone fragments; medium acid; gradual wavy boundary.

C—11 to 17 inches; dark brown (7.5YR 4/4) channery loam, brown (7.5YR 5/4) dry; massive; slightly hard, friable; many very fine and fine and common medium roots; about 25 percent small sandstone fragments; medium acid; abrupt irregular boundary.

R—17 inches; fine grained sandstone.

The thickness of the solum ranges from 8 to 20 inches. The mollic epipedon is 7 to 12 inches thick. Sandstone fragments are throughout the solum in some pedons. The bedrock is moderately hard and in some pedons is interbedded with shale. The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is dominantly loam, but the range includes fine sandy loam. The C horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is loam or channery loam.

Dennis series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in silty and clayey material weathered from shale. Slope ranges from 2 to 5 percent.

Dennis soils are similar to Kenoma, Summit, and Welda soils and are commonly adjacent to Bates, Collinsville, and Kenoma soils. Kenoma soils have an abrupt textural change between the A and B2 horizons. They are on the less sloping parts of the landscape. Summit and Welda soils are in positions on the landscape similar to those of the Dennis soils. Summit soils have a silty clay loam A horizon and have chroma of less than 3 in the B2 horizon. Welda soils lack a mollic epipedon. Bates soils have a solum that is less than 40 inches thick. They are higher on the landscape than the Dennis soils. Collinsville soils are less than 20 inches deep over bedrock. They are on the steeper side slopes above the Dennis soils.

Typical pedon of Dennis silt loam, in an area of Dennis-Bates complex, 2 to 6 percent slopes, 1,400 feet south and 60 feet east of the northwest corner of sec. 23, T. 17 S., R. 19 E.

A1—0 to 10 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium granular structure; slightly hard, friable; many very fine and fine and few medium roots; medium acid; clear wavy boundary.

B1—10 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; weak medium subangular blocky structure; slightly hard, friable;

common very fine and few fine roots; medium acid; gradual smooth boundary.

B21t—15 to 25 inches; olive brown (2.5Y 4/4) silty clay, light olive brown (2.5Y 5/4) dry; many medium and coarse distinct strong brown (7.5YR 5/6) and very dark grayish brown (2.5Y 3/2) mottles; moderate fine and medium subangular blocky structure; very hard, firm; common very fine roots; few black concretions; medium acid; gradual smooth boundary.

B22t—25 to 44 inches; olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) silty clay, light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6) dry; common medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; very hard, very firm; few very fine roots; common black concretions; medium acid; gradual smooth boundary.

B3—44 to 60 inches; yellowish brown (10YR 5/6) and olive brown (2.5Y 4/4) silty clay loam; common medium distinct red (2.5YR 4/6) and few medium distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; hard, firm; few very fine roots; few black concretions; about 3 percent shale fragments 5 to 20 millimeters in diameter; slightly acid.

The solum is more than 60 inches thick. The A horizon has hue of 10YR and value and chroma of 2 or 3. It is loam or silt loam. It is neutral to strongly acid unless limed. The B1 horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is silty clay loam or clay loam. It is medium acid or strongly acid. The B2t horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It has common or many mottles of gray, brown, red, or yellow. It is silty clay loam, clay, or silty clay; it averages as low as 35 percent clay in some pedons and as high as 45 percent clay in others. It is slightly acid to strongly acid.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from silty and clayey shale. Slope ranges from 3 to 12 percent.

Eram soils are similar to Lebo and Summit soils and are commonly adjacent to Clareson, Dennis, Lebo, Lula, and Summit soils. Lebo and Clareson soils are higher on the landscape than the Eram soils. Lebo soils have shale fragments in the subsoil. Clareson soils have a flaggy B2t horizon. Dennis and Lula soils have a solum that is more than 40 inches thick. They are in areas below or above the Eram soils. Summit soils have a mollic epipedon that is more than 28 inches thick. They are lower on the landscape than the Eram soils.

Typical pedon of Eram silty clay loam, in an area of Clareson-Eram silty clay loams, 3 to 15 percent slopes, 2,000 feet west and 125 feet south of the northeast corner of sec. 20, T. 15 S., R. 19 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine granular structure; hard, firm; slightly acid; clear smooth boundary.

B21t—7 to 16 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure; very hard, very firm; thin films on faces of some peds; few fine black concretions; slightly acid; gradual smooth boundary.

B22t—16 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; common fine faint olive brown (2.5Y 4/4) mottles; weak and moderate medium blocky structure; very hard, very firm; thin films on faces of some peds; few fine black concretions; slightly acid; diffuse smooth boundary.

B3—28 to 38 inches; coarsely mottled yellowish brown (10YR 5/4) and light brownish gray (2.5Y 6/2) silty clay loam, light yellowish brown (10YR 6/4) and light gray (2.5Y 7/2) dry; weak medium blocky structure; hard, firm; some visible voids and root holes coated with dark stains; few black concretions; slightly acid; clear wavy boundary.

Cr—38 inches; weathered shale.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon is 12 to 28 inches thick. The A horizon has hue of 10YR and value and chroma of 2 or 3. It is dominantly silty clay loam but in some pedons is silt loam. It is slightly acid or medium acid. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It is neutral to medium acid. It is silty clay, clay, or silty clay loam. In some pedons the content of shale and sandstone fragments in this horizon is as much as 15 percent. In some pedons calcium carbonate concretions are in the lower part of the B horizon.

Hector series

The Hector series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 2 to 12 percent.

Hector soils are similar to Bolivar and Collinsville soils and are commonly adjacent to Bates, Bolivar, and Welda soils. Bolivar and Collinsville soils are in positions on the landscape similar to those of the Hector soils. Bolivar soils have an argillic horizon and are 20 to 40 inches deep over bedrock. Collinsville soils have a mollic epipedon. Bates soils also have a mollic epipedon. They are in areas above the Hector soils. Welda soils have an argillic horizon. They are in areas below the Hector soils.

Typical pedon of Hector loam, in an area of Bolivar-Hector loams, 6 to 12 percent slopes, 125 feet west and

900 feet south of the northeast corner of sec. 13, T. 17 S., R. 18 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; slightly acid; clear smooth boundary.
A2—3 to 9 inches; dark brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; weak fine and medium granular structure; slightly hard, very friable; many very fine and fine roots; less than 5 percent small sandstone fragments; medium acid; gradual wavy boundary.
B2—9 to 18 inches; yellowish brown (10YR 5/4) loam, moist or dry; weak medium subangular blocky structure; slightly hard, friable; many very fine and fine and few medium and coarse roots; about 10 percent sandstone fragments; strongly acid; abrupt irregular boundary.
R—18 inches; fine grained sandstone.

The thickness of the solum ranges from 10 to 20 inches. The A1 horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It is dominantly loam, but the range includes fine sandy loam. The A2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. The B horizon has hue of 10YR or 7.5YR, value of 5, and chroma of 4 to 6. It is loam or fine sandy loam. The sandstone bedrock is moderately hard and in some pedons is interbedded with silty shale.

Kenoma series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands and high terraces. These soils formed in silty and clayey sediments. Slope ranges from 1 to 4 percent.

Kenoma soils are similar to Dennis, Summit, and Woodson soils and are commonly adjacent to Dennis, Leanna, Lula, and Woodson soils. Dennis and Summit soils do not have an abrupt textural change between the A and B2t horizons. They are commonly in areas below the Kenoma soils. Leanna soils have an albic horizon. They are lower on the landscape than the Kenoma soils. Lula soils are 40 to 60 inches deep over limestone bedrock. They are in areas below the Kenoma soils. Woodson soils have chroma of 1 in the B21t horizon. They are in the slightly less sloping areas.

Typical pedon of Kenoma silt loam, 1 to 4 percent slopes, 100 feet south and 1,300 feet west of the northeast corner of sec. 17, T. 18 S., R. 18 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.
A12—6 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure in the upper 3 inches and weak fine subangular blocky structure in the lower 2 inches; slightly hard, friable; common worm casts; medium acid; abrupt wavy boundary.
B21t—11 to 20 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; common fine faint reddish brown (5YR 4/4) mottles; moderate medium and coarse prismatic structure parting to moderate medium and coarse blocky; very hard, very firm; common very fine roots; few fine black concretions; medium acid; gradual smooth boundary.
B22t—20 to 34 inches; dark brown (10YR 3/3) silty clay, brown (10YR 4/3) dry; few medium faint yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak coarse blocky; very hard, very firm; few very fine roots, mostly between peds; few fine black concretions; slightly acid; gradual smooth boundary.
B3—34 to 60 inches; coarsely mottled reddish brown (5YR 4/4), dark brown (7.5YR 4/4), and brown (10YR 4/3) silty clay; weak coarse blocky structure; very hard, very firm; few fine black concretions; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. In some pedons rounded chert pebbles are throughout the profile, but the content of these pebbles is, by volume, less than 20 percent in any one horizon. In some pedons the depth to limestone or shale is less than 60 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is dominantly silt loam but in some pedons is silty clay loam. It is slightly acid to strongly acid. The B2 horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is slightly acid or medium acid. The B3 horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6, and chroma of 2 to 6. It is mildly alkaline to medium acid. The B horizon is silty clay or clay.

Leanna series

The Leanna series consists of deep, somewhat poorly drained, very slowly permeable soils on flood plains and low terraces. These soils formed in silty and clayey alluvium. Slope ranges from 0 to 2 percent.

Leanna soils are commonly adjacent to Kenoma, Osage, and Verdigris soils. Kenoma soils do not have an albic horizon. They are higher on the landscape than the Leanna soils. Osage and Verdigris soils do not have an argillic horizon or an A2 horizon. They are on the slightly lower parts of the landscape.

Typical pedon of Leanna silt loam, 200 feet west and 2,100 feet north of the southeast corner of sec. 17, T. 18 S., R. 19 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate very fine and fine

granular structure; slightly hard, friable; common very fine and fine roots; common worm casts; neutral (limed); clear smooth boundary.

A2—8 to 17 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; few fine faint brownish yellow (10YR 6/6) mottles; weak very fine and fine granular structure; slightly hard, friable; common very fine and fine roots; few worm casts; few very fine black concretions; medium acid; clear wavy boundary.

B2t—17 to 32 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; common fine distinct brownish yellow (10YR 6/6) mottles; moderate medium and coarse subangular blocky structure; hard, firm; few very fine roots; gray coatings on vertical faces of peds in the upper part; few fine black concretions; strongly acid; diffuse smooth boundary.

B3—32 to 51 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; many coarse distinct yellowish brown (10YR 5/4) mottles; weak coarse blocky structure, massive when moist; very hard, very firm; few fine black concretions; dark stains in root holes; slightly acid; diffuse smooth boundary.

C—51 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; massive; very hard, very firm; common fine black concretions; slightly acid.

The thickness of the solum ranges from 45 to more than 60 inches. The Ap or A1 horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly silt loam but in some pedons is silty clay loam. Unless limed, it is slightly acid to strongly acid. The A2 horizon has hue of 10YR, value of 3 to 5, and chroma of 1 or 2. It is silt loam or silty clay loam. It is medium acid or strongly acid. The B2t horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is silty clay or silty clay loam that ranges from 35 to 45 percent clay. It is slightly acid to strongly acid. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. It is silty clay or silty clay loam.

Lebo series

The Lebo series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 10 to 30 percent.

Lebo soils are similar to Eram soils and are commonly adjacent to Eram and Lula soils. The adjacent soils have an argillic horizon. They generally are less steep than the Lebo soils. Eram soils are in areas below the Lebo soils or are in similar positions on the landscape. Lula soils are in areas above the Lebo soils.

Typical pedon of Lebo silty clay loam, in an area of Eram-Lebo silty clay loams, 7 to 12 percent slopes, 1,800 feet west and 150 feet north of the southeast corner of sec. 3, T. 19 S., R. 21 E.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; many fine roots; less than 5 percent limestone, sandstone, and chert fragments; slightly acid; gradual wavy boundary.

B2—7 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and very fine subangular blocky structure; hard, friable; many pores; many fine roots; about 15 percent fine shale fragments; slightly acid; gradual wavy boundary.

B3—14 to 28 inches; grayish brown (10YR 5/2) shaly silty clay loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; hard, friable; common very fine and fine roots that decrease in number with increasing depth; about 45 percent silty shale fragments; slightly acid; clear smooth boundary.

Cr—28 inches; weathered silty shale.

The mollic epipedon is 7 to 16 inches thick. The solum ranges from 20 to 40 inches in thickness. It ranges from mildly alkaline to medium acid. It has thin strata of hard shale, sandstone, or siltstone. It is silty clay loam, silt loam, shaly silty clay loam, or channery silty clay loam. The A horizon has hue of 10YR and value and chroma of 2 or 3. In some pedons flaggy limestone fragments and stones are on the surface and in the A horizon. The B horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4.

Lula series

The Lula series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in silty and clayey material weathered from limestone and shale. Slope ranges from 0 to 5 percent.

The Lula soils in this county are taxadjuncts to the Lula series because the content of clay is more than 35 percent in the control section. This difference, however, does not alter the use or behavior of the soils.

Lula soils are similar to Clareson and Mason soils and are commonly adjacent to Clareson, Eram, Kenoma, and Woodson soils. Clareson soils are less than 40 inches deep over limestone and have a flaggy B2t horizon. They are in areas below the Lula soils. Eram soils are less than 40 inches deep over shale. They are in areas above the Lula soils. Kenoma and Woodson soils also are in areas above the Lula soils. They have an abrupt boundary between the A and B2t horizons. Mason soils do not have bedrock within a depth of 60 inches. They are on terraces.

Typical pedon of Lula silt loam, 0 to 2 percent slopes, 300 feet north and 2,100 feet east of the southwest corner of sec. 19, T. 15 S., R. 18 E.

Ap—0 to 7 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) dry; moderate medium granular structure; slightly hard, friable; few fine roots; few worm casts; slightly acid; clear smooth boundary.
B1—7 to 12 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; strong fine subangular blocky structure; hard, firm; few fine roots; few worm casts; medium acid; gradual smooth boundary.
B21t—12 to 20 inches; dark reddish brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) dry; moderate fine and medium subangular blocky structure; hard, firm; few very fine roots; thin films on most peds; few fine black concretions; few worm casts; medium acid; gradual smooth boundary.
B22t—20 to 39 inches; dark reddish brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) dry; moderate fine and medium subangular blocky structure; very hard, very firm; few very fine roots; thin films on peds; dark stains on most peds; few fine black concretions; medium acid; gradual smooth boundary.
B3—39 to 44 inches; reddish brown (5YR 4/4) silty clay loam, reddish brown (5YR 5/4) dry; many medium and coarse distinct brownish yellow (10YR 6/6) mottles; weak fine and medium subangular blocky structure; very hard, very firm; thin films on some peds; few fine black concretions; neutral; abrupt irregular boundary.
R—44 inches; limestone.

The thickness of the solum, or the depth to limestone, ranges from 40 to 60 inches. The mollic epipedon is more than 16 inches thick. A few chert fragments are throughout some pedons. The A horizon has hue of 7.5YR or 10YR and value and chroma of 2 or 3. It is dominantly silt loam, but the range includes silty clay loam. The B2t horizon has hue of 5YR, 2.5YR, or 7.5YR, value of 3 or 4, and chroma of 3 to 6. It is silty clay loam or silty clay. It is medium acid or strongly acid. The R horizon ranges from thick, massive limestone layers to thin, broken layers that are interbedded with shale.

Mason series

The Mason series consists of deep, well drained, moderately slowly permeable soils on terraces. These soils formed in silty alluvium. Slopes are 0 to 2 percent.

Mason soils are similar to Lula soils and are commonly adjacent to Osage and Verdigris soils. Lula soils are 40 to 60 inches deep over limestone bedrock. They are on uplands. Osage and Verdigris soils lack an argillic horizon. They are on flood plains.

Typical pedon of Mason silt loam, 1,600 feet north and 500 feet east of the southwest corner of sec. 19, T. 15 S., R. 18 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.
A12—7 to 14 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.
B2t—14 to 36 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and very fine subangular blocky structure; slightly hard, friable; few fine black concretions; slightly acid; gradual smooth boundary.
B3—36 to 52 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; common fine faint dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; hard, firm; common fine black concretions and stains; slightly acid; diffuse smooth boundary.
C—52 to 60 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm; neutral; few fine black concretions and stains.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is more than 20 inches thick. The A horizon has hue of 10YR and value and chroma of 2 or 3. It ranges from neutral to strongly acid. It is dominantly silt loam, but the range includes silty clay loam. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. It is slightly acid or medium acid. The C horizon has colors similar to those of the B horizon, but it is mottled with yellowish brown, gray, or red in many pedons.

Olpe series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in gravelly old alluvium. Slope ranges from 1 to 5 percent.

Olpe soils are similar to Clareson soils and are commonly adjacent to Bates, Dennis, and Kenoma soils. Clareson soils have flaggy limestone fragments in the subsoil. They are in areas below the Olpe soils. Bates and Dennis soils have few or no chert pebbles in the solum. They are in areas below the Olpe soils. Kenoma soils are on uplands and high terraces. The content of chert pebbles in the solum of these soils is less than 20 percent.

Typical pedon of Olpe silty clay loam (fig. 10), in an area of Olpe-Kenoma complex, 1 to 5 percent slopes, 1,000 feet north and 100 feet east of the southwest corner of sec. 14, T. 17 S., R. 20 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong fine and medium granular structure; slightly hard, friable; about 5 percent chert pebbles; slightly acid; gradual wavy boundary.
B1—10 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2)

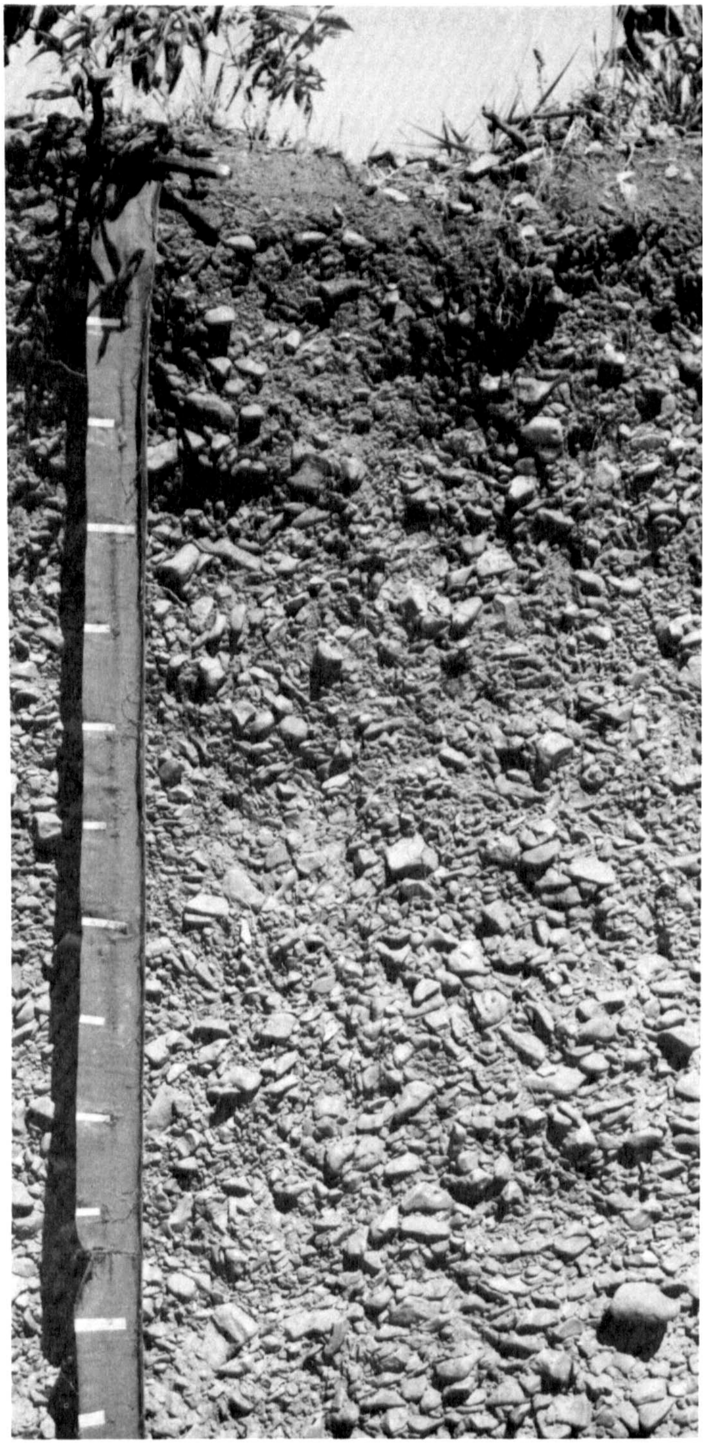

Figure 10.—Profile of Olpe silty clay loam. The subsoil is very gravelly. The scale is in feet.

dry; moderate fine subangular blocky structure; hard, firm; about 10 percent rounded chert pebbles; slightly acid; gradual wavy boundary.

B21t—16 to 30 inches; dark brown (7.5YR 3/4) very gravelly clay loam, brown (7.5YR 4/4) dry; moderate fine subangular blocky structure; very hard, very firm; about 75 percent rounded chert pebbles; slightly acid; gradual wavy boundary.

B22t—30 to 44 inches; reddish brown (5YR 4/4) very gravelly clay, reddish brown (5YR 4/4) dry; many coarse distinct dark gray (10YR 4/1) mottles below 36 inches; moderate fine subangular blocky structure; very hard, very firm; about 50 percent rounded chert pebbles; few fine black concretions; neutral; diffuse wavy boundary.

B3—44 to 60 inches; coarsely mottled brown (7.5YR 4/4), dark gray (10YR 4/1), and reddish brown (5YR 4/4) very gravelly clay; weak coarse blocky structure; very hard, very firm; about 30 percent rounded chert pebbles; common fine black concretions; slightly acid.

The solum is more than 60 inches thick. It is neutral to medium acid. The very gravelly layer is 1 foot to several feet thick. The A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 to 3. It is dominantly silty clay loam but in some pedons is silt loam, gravelly silt loam, or gravelly loam. The B2 horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 3 to 6.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey and silty alluvium. Slope is 0 to 1 percent.

Osage soils are commonly adjacent to Mason and Verdigris soils. Mason soils have an argillic horizon. They are on terraces. Verdigris soils are fine-silty. They are nearer the stream than the Osage soils.

Typical pedon of Osage silty clay, 2,200 feet west and 250 feet south of the northeast corner of sec. 8, T. 17 S., R. 19 E.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; very hard, firm; common very fine and fine roots; slightly acid; clear smooth boundary.

A12—6 to 17 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine faint olive brown (2.5Y 4/4) mottles; moderate fine subangular blocky structure; very hard, very firm; few worm casts; slightly acid; gradual smooth boundary.

B21g—17 to 32 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct brownish yellow (10YR 6/6) mottles; weak coarse blocky structure; very hard, very firm; few visible pores; few fine black concretions; neutral; diffuse smooth boundary.

B22g—32 to 50 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; common fine distinct

brownish yellow (10YR 6/6) mottles; weak coarse blocky structure; very hard, very firm; few fine black concretions; common slickensides; neutral; diffuse smooth boundary.

C—50 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common fine distinct brownish yellow (10YR 6/6) mottles; massive; very hard, very firm; few fine black concretions; common slickensides; neutral.

The solum is more than 40 inches thick. It is neutral to medium acid. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. The upper part of the B2 horizon has the same color as the A horizon. The lower part has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of less than 2. The clay content of the B and C horizons ranges from 40 to 60 percent.

Summit series

The Summit series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from silty and clayey shale. Slope ranges from 1 to 7 percent.

Summit soils are similar to Dennis, Eram, and Kenoma soils and are commonly adjacent to Eram, Kenoma, Lebo, Lula, and Woodson soils. Dennis soils have a silt loam A horizon. They are in positions on the landscape similar to those of the Summit soils. Eram soils have a solum that is less than 40 inches thick. They are in areas above the Summit soils. Kenoma and Woodson soils have an abrupt boundary between the A and B2t horizons. They are in areas below the Summit soils. Lebo and Lula soils are in areas above the Summit soils. Lebo soils do not have an argillic horizon. Lula soils are 40 to 60 inches deep over limestone bedrock.

Typical pedon of Summit silty clay loam, 3 to 7 percent slopes, 2,300 feet south and 225 feet west of the northeast corner of sec. 25, T. 15 S., R. 18 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; many very fine and fine roots; medium acid; clear smooth boundary.

B1—6 to 14 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium blocky structure; hard, firm; many very fine and common fine roots; few very fine black concretions; medium acid; clear smooth boundary.

B21t—14 to 28 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; very hard, very firm; few very fine roots; few fine black concretions; dark films and stains on peds; medium acid; gradual smooth boundary.

B22t—28 to 40 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few medium distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium blocky structure; very hard, very firm; few very fine roots, commonly between peds; few fine black concretions; slightly acid; gradual smooth boundary.

B3—40 to 57 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium blocky; very hard, very firm; few very fine roots, mostly between peds; few fine black concretions and stains; slightly acid; gradual smooth boundary.

C—57 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few fine distinct brownish yellow (10YR 6/6) mottles; massive; very hard, very firm; few fine black concretions; neutral.

The solum ranges from 50 to more than 60 inches in thickness. The mollic epipedon is more than 28 inches thick. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is slightly acid or medium acid. The B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 to 3. It is silty clay or clay in which the content of clay ranges from 40 to 50 percent. It is neutral to medium acid. The C horizon has hue of 10YR, 7.5YR, or 2.5Y and value and chroma of 2 to 4. It is silty clay loam or silty clay in which the content of clay ranges from 35 to 50 percent. In some pedons it has a few calcium carbonate concretions.

Verdigris series

The Verdigris series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 2 percent.

Verdigris soils are commonly adjacent to Mason and Osage soils. Mason soils have an argillic horizon. They are on terraces. Osage soils have a clayey subsoil. They are in the lower areas on the flood plain.

Typical pedon of Verdigris silt loam, 300 feet south and 250 feet east of the center of sec. 5, T. 19 S., R. 21 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium granular structure; platy structure in a thin layer in the lower part; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A12—7 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, friable; many fine roots; many continuous very fine pores; neutral; gradual smooth boundary.

AC—16 to 28 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2)

dry; weak medium subangular blocky structure; hard, friable; many fine roots; many continuous very fine pores; slightly acid; gradual smooth boundary.

C—28 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; massive; hard, friable; many continuous very fine pores; few fine black concretions; slightly acid.

The thickness of the solum ranges from 24 to 60 inches. The mollic epipedon is more than 24 inches thick. The A horizon has hue of 10YR or 7.5YR and value and chroma of 2 or 3. It is dominantly silt loam but in some pedons is silty clay loam. It is neutral to medium acid. The C horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. It is silt loam or silty clay loam.

Welda series

The Welda series consists of deep, well drained, moderately slowly permeable soils on uplands and terraces. These soils formed in silty colluvium and alluvium. Slope ranges from 2 to 6 percent.

The Welda soils in this county have a mean annual soil temperature that is higher than is defined as the range for the Welda series. This difference, however, does not alter the use or behavior of the soils.

Welda soils are similar to Dennis soils and are commonly adjacent to Bolivar, Hector, Kenoma, and Verdigris soils. Dennis soils have a mollic epipedon. They are in positions on the landscape similar to those of the Welda soils. Bolivar, Hector, and Kenoma soils are in areas above the Welda soils. Bolivar soils have a solum that is less than 40 inches thick. Hector soils are less than 20 inches deep to bedrock. Kenoma soils do not have an A2 horizon. Verdigris soils do not have an A2 horizon or an argillic horizon. They are in areas below the Welda soils.

Typical pedon of Welda silt loam, 2 to 6 percent slopes, 2,160 feet south and 25 feet east of the northwest corner of sec. 9, T. 19 S., R. 21 E.

A1—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, very friable; common fine roots; few worm casts; neutral; clear smooth boundary.

A2—6 to 11 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; moderate medium granular structure; hard, friable; common fine roots; few open pores; few worm casts; medium acid; clear smooth boundary.

B21t—11 to 23 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films; few open pores; slightly acid; gradual smooth boundary.

B22t—23 to 36 inches; dark brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; common medium faint dark grayish brown (10YR 4/2) mottles; weak fine blocky structure; extremely hard, very firm; thin patchy clay films; few fine black concretions; slightly acid; gradual smooth boundary.

B3—36 to 50 inches; brown (7.5YR 4/4) silty clay, brown (7.5YR 5/4) dry; many medium faint dark grayish brown (10YR 4/2) mottles; weak fine blocky structure; very hard, very firm; thin patchy clay films; few open pores; few black concretions; very few fine roots; slightly acid; gradual smooth boundary.

C—50 to 60 inches; brown (10YR 5/3) and dark grayish brown (10YR 4/2) silty clay loam, pale brown (10YR 6/3) and grayish brown (10YR 5/2) dry; common fine distinct yellowish red (5YR 4/6) mottles; massive; extremely hard, very firm; few fine black concretions; slightly acid.

The solum is more than 40 inches thick. The A1 horizon has hue of 10YR and value and chroma of 2 or 3. It is dominantly silt loam but in some pedons is silty clay. It ranges from neutral to strongly acid. The A2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is silt loam or loam. It is slightly acid to strongly acid. The B2t horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 to 6. It is silty clay loam or silty clay.

Woodson series

The Woodson series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands and high terraces. These soils formed in clayey and silty sediments. Slope ranges from 0 to 2 percent.

Woodson soils are similar to Kenoma soils and are commonly adjacent to Kenoma, Lula, and Summit soils. Kenoma soils have chroma of 2 or more in the B2t horizon. They are in positions on the landscape similar to those of the Woodson soils. Lula soils do not have an abrupt boundary to the argillic horizon and are 40 to 60 inches deep over bedrock. They are in areas below the Woodson soils. Summit soils do not have an abrupt boundary to the argillic horizon. They are on slopes above the Woodson soils.

Typical pedon of Woodson silt loam, 0 to 1 percent slopes, 75 feet east and 600 feet north of the southwest corner of sec. 6, T. 16 S., R. 21 E.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

A12—7 to 12 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; abrupt smooth boundary.

B21t—12 to 19 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine faint

yellowish brown (10YR 5/6) mottles; weak and moderate medium blocky structure; very hard, very firm; common very fine roots, mostly between peds; common shiny faces or films on peds; few black concretions; medium acid; gradual smooth boundary.

B22t—19 to 30 inches; very dark gray (10YR 3/1) silty clay, gray (2.5Y 5/1) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak and moderate medium and coarse blocky structure; very hard, very firm; few very fine roots, mostly between peds; common shiny faces or films on peds; few black concretions; slightly acid; gradual smooth boundary.

B3—30 to 43 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few medium distinct yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; very hard, very firm; few very fine roots between peds; few black concretions; slightly acid; gradual smooth boundary.

C—43 to 60 inches; gray (10YR 5/1) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; hard, firm; few black concretions; slightly acid.

The solum ranges from 36 to 60 inches in thickness. It is slightly acid or medium acid. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or less. It is dominantly silt loam, but the range includes silty clay loam. The B2t horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1.5 or less. In some pedons gray coatings are on peds in the upper part of this horizon. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is silty clay loam or silty clay that ranges from 37 to 50 percent clay.

factors of soil formation

Soil forms through processes that act on deposited or accumulated geologic material. As a result of these processes, it is constantly changing. The characteristics of the soil at any given point are determined by the interaction among five factors of soil formation—the physical and mineral composition of the parent material; the climate; the plant and animal life on and in the soil; the relief; and the length of time that the forces of soil formation have acted on the soil material. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of the individual factors vary from place to place.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a soil that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

parent material

The weathering of accumulated geologic material results in the parent material in which soils form. Parent material affects the texture and most other properties of the soil. Differences among soils mainly are the result of differences among the parent materials. The soils in Franklin County formed in residuum of limestone, sandstone, and shale of the Pennsylvanian System and in the sediment of the Tertiary and Quaternary Systems that was transported by water and wind.

The weathering of Upper Pennsylvanian limestone, sandstone, and shale resulted in the parent material in which most of the soils in the county formed. Bates, Bolivar, Clareson, Collinsville, Dennis, Eram, Hector, Lebo, Lula, and Summit soils formed in material weathered from local bedrock. Dennis, Eram, Lebo, and Summit soils formed in material weathered from silty and clayey shale. Bates, Bolivar, Collinsville, and Hector soils formed in material weathered from sandstone and interbedded silty shale. Clareson soils formed in material weathered from limestone. Lula soils formed in material weathered from limestone and shale.

Old and recent alluvium is sediment that was transported by water. The old alluvial sediment of the Tertiary and Quaternary Systems is on the uplands or high terraces along the Marais Des Cygnes River. Kenoma, Olpe, and Woodson soils formed in this material. In some areas the Kenoma and Woodson soils formed in a thin deposit of wind-transported silty sediment or have been modified by this sediment. Recent alluvial sediment is on flood plains and low terraces along the Marais Des Cygnes River and its tributaries. Leanna, Osage, and Verdigris soils are on these flood plains or low terraces. The Leanna and Osage soils formed in silty and clayey sediment, and the Verdigris soils formed in silty sediment.

climate

Climate affects physical and chemical weathering and the biological forces at work in the parent material. The downward movement of water is a major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends on temperature, intensity of precipitation, humidity, relief, and nature of the soil material. Soil-forming processes are most active when the soil is warm and moist. Soil structure is modified by freezing and thawing and by the frequent alternating wet and dry periods characteristic of the climate in the county.

Climate results in important differences among the soils throughout a wide region, but it results in only slight differences among the soils in a smaller area, such as one the size of Franklin County.

plant and animal life

Soil formation is accompanied by changes in plant and animal life. The biological life responds to changes in soil features and, in a given climatic region, to the other factors of soil formation. In turn, the plant and animal life affects soil formation.

Plants provide a protective cover, add organic material, and bring nutrients from lower layers to the surface layer. Organic matter forms when plant and animal microorganisms decompose trunks, stems,

leaves, and roots. It alters the soil physically and chemically by affecting color, structure, and other soil properties. Also, it creates a favorable environment for biological activity within the soil.

Most of the soils in Franklin County formed under a cover of tall prairie grasses. Clareson and other soils formed under a mixture of tall and mid prairie grasses. Bolivar, Hector, and Welda soils and the soils that formed in recent alluvium formed under a cover of tall prairie grasses and hardwood trees.

Because they help to decompose organic material and weather the parent material, animals affect some soil properties. Worms, for example, affect the color and structure of the soil.

Human activities greatly affect soil formation. They tend to offset the normal soil-forming processes. In most areas they have increased the extent of erosion; increased or decreased the organic matter content; and, through land leveling and industrial or urban development, changed the relief.

relief

Relief affects soil formation through its effect on runoff, drainage, and other factors related to the movement of water, including geologic and accelerated erosion. The amount of water that enters the soil depends partly on relief. Generally, less water enters the steeper soils and more soil material is lost through erosion. In most level or depressional areas, the amount of available moisture is increased by the runoff from higher lying areas. Because of this additional water, the upper layers of the soil are gray or mottled and tend to be thick. The profile of Kenoma, Woodson, and other nearly level or gently sloping soils generally is more strongly expressed than that of steeper soils, such as Lebo soils. Runoff is slowed on the nearly level soils, and more water moves through the soil or ponds on the surface. Most of the nearly level soils formed in alluvium receive new sediment during periods of flooding.

time

As water moves through the soil, soluble matter and fine particles gradually are leached from the surface layer to the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that penetrates the surface. Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. For example, the young Verdigris soils, which formed in recent alluvium, show very little evidence of horizon development other than a slight darkening of the surface layer. In contrast, the older Woodson soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

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glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedding system. A series of elevated beds separated by shallow ditches and created by plowing or grading fields. A bedding system improves surface drainage.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clayey soil. Sandy clay, silty clay, or clay.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. Keeping stubble, stalks, and other crop residue on the surface to help control soil blowing and water erosion, to conserve water, and to decrease the evaporation rate.

Crop rotation. A planned sequence of crops grown in a regular recurring succession, as contrasted with one crop grown year after year and with different crops grown in a haphazard order.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flaggy soil. A soil in which the content of flagstones is, by volume, more than 15 percent.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only

after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loamy soil. Sandy loam, loam, clay loam, sandy clay loam, silt, silt loam, or silty clay loam.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slickspot. A small area of soil having a puddled, crusted, or smooth surface and an excess of

exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-76 at Ottawa, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.5	19.5	30.0	71	-9	1.23	0.45	2.02	3	6.4
February---	46.5	25.0	35.8	75	-2	1.35	0.52	2.37	3	4.8
March------	55.3	32.3	43.8	84	6	2.62	1.11	3.36	5	5.3
April------	68.3	44.6	56.5	90	23	3.30	2.16	4.78	6	0.8
May--------	77.5	54.5	66.0	93	32	4.90	3.43	6.66	7	0.0
June-------	85.6	63.6	74.6	99	46	5.22	2.80	8.06	8	0.0
July-------	90.8	67.8	79.3	106	50	4.48	1.84	6.17	6	0.0
August-----	90.0	65.8	77.9	104	49	4.26	1.72	7.56	5	0.0
September--	81.7	57.3	69.5	99	37	4.93	1.75	8.23	6	0.0
October----	71.7	46.7	59.2	91	24	3.07	1.13	5.06	5	0.0
November---	56.0	34.0	45.0	78	8	1.81	0.17	3.11	3	1.6
December---	44.2	24.6	34.4	70	-3	1.43	0.75	1.97	4	4.9
Year-----	67.3	44.6	56.0	107	-9	38.60	32.59	45.46	61	23.8

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1931-60 at Ottawa, Kansas]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 8	April 18	April 30
2 years in 10 later than--	April 3	April 13	April 25
5 years in 10 later than--	March 25	April 3	April 15
First freezing temperature in fall:			
1 year in 10 earlier than--	October 26	October 17	October 8
2 years in 10 earlier than--	October 30	October 22	October 12
5 years in 10 earlier than--	November 9	October 31	October 22

TABLE 3.--GROWING SEASON

[Recorded in the period 1931-60 at Ottawa, Kansas]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	208	191	169
8 years in 10	215	198	176
5 years in 10	229	211	189
2 years in 10	242	224	202
1 year in 10	250	231	209

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Bc	Bates loam, 1 to 4 percent slopes	3,195	0.9
Bd	Bates-Collinsville loams, 3 to 7 percent slopes	7,100	1.9
Bh	Bates-Collinsville loams, 7 to 12 percent slopes	10,520	2.8
Bo	Bolivar-Hector loams, 2 to 6 percent slopes	1,060	0.3
Bs	Bolivar-Hector loams, 6 to 12 percent slopes	3,185	0.9
Cm	Clareson-Eram silty clay loams, 3 to 15 percent slopes	31,440	8.5
Dc	Dennis silt loam, 2 to 5 percent slopes	7,310	2.0
Dn	Dennis-Bates complex, 2 to 6 percent slopes	31,310	8.5
Do	Dennis-Bates complex, 3 to 6 percent slopes, eroded	2,630	0.7
Ea	Eram-Lebo silty clay loams, 7 to 12 percent slopes	2,870	0.8
Ec	Eram-Lula complex, 3 to 7 percent slopes	30,950	8.4
Ke	Kenoma silt loam, 1 to 4 percent slopes	60,380	16.4
Le	Leanna silt loam	6,360	1.7
Ln	Lebo-Rock outcrop complex, 20 to 40 percent slopes	3,490	0.9
Lo	Lula silt loam, 0 to 2 percent slopes	36,715	9.9
Mb	Mason silt loam	1,265	0.3
Oe	Olpe-Kenoma complex, 1 to 5 percent slopes	2,085	0.6
Os	Osage silty clay loam	4,740	1.3
Ov	Osage silty clay	11,820	3.2
Pt	Pits, quarries	355	0.1
Sn	Summit silty clay loam, 1 to 3 percent slopes	1,755	0.5
So	Summit silty clay loam, 3 to 7 percent slopes	20,975	5.7
Vb	Verdigris silt loam	28,925	7.8
Vc	Verdigris silt loam, channeled	7,560	2.0
Wb	Welda silt loam, 2 to 6 percent slopes	435	0.1
Wo	Woodson silt loam, 0 to 1 percent slopes	8,840	2.4
Ws	Woodson silt loam, 1 to 2 percent slopes	42,010	11.4
	Total	369,280	100.0

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
Bc	Bates loam, 1 to 4 percent slopes
Dc	Dennis silt loam, 2 to 5 percent slopes
Dn	Dennis-Bates complex, 2 to 6 percent slopes
Do	Dennis-Bates complex, 3 to 6 percent slopes, eroded
Ke	Kenoma silt loam, 1 to 4 percent slopes
Le	Leanna silt loam
Lo	Lula silt loam, 0 to 2 percent slopes
Mb	Mason silt loam
Os	Osage silty clay loam (where drained)
Ov	Osage silty clay (where drained)
Sn	Summit silty clay loam, 1 to 3 percent slopes
So	Summit silty clay loam, 3 to 7 percent slopes
Vb	Verdigris silt loam
Wb	Welda silt loam, 2 to 6 percent slopes
Wo	Woodson silt loam, 0 to 1 percent slopes
Ws	Woodson silt loam, 1 to 2 percent slopes

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Winter wheat	Tall fescue	Soybeans	Corn	Smooth brome
	Bu	Bu	AUM*	Bu	Bu	AUM*
Bc------------------------ Bates	60	36	5.0	26	50	5.0
Bd------------------------ Bates-Collinsville	50	30	4.5	20	45	4.5
Bo------------------------ Bolivar-Hector	50	28	4.5	18	40	4.5
Dc------------------------ Dennis	75	38	5.5	28	70	5.5
Dn------------------------ Dennis-Bates	70	38	5.5	28	65	5.5
Do------------------------ Dennis-Bates	65	36	5.0	26	60	5.0
Ea------------------------ Eram-Lebo	---	---	4.5	---	---	4.5
Ec------------------------ Eram-Lula	60	32	5.0	22	55	5.0
Ke------------------------ Kenoma	65	34	4.5	26	60	4.5
Le------------------------ Leanna	80	36	6.5	32	75	6.5
Lo------------------------ Lula	85	40	6.0	28	70	6.0
Mb------------------------ Mason	105	44	7.0	36	100	7.0
Oe------------------------ Olpe-Kenoma	50	30	4.5	22	45	4.5
Os------------------------ Osage	80	35	6.5	34	75	6.5
Ov------------------------ Osage	65	30	6.0	28	60	6.0
Sn------------------------ Summit	75	38	5.5	30	70	5.5
So------------------------ Summit	70	34	5.5	28	65	5.5
Vb------------------------ Verdigris	100	40	7.0	34	95	7.0
Wb------------------------ Welda	75	36	5.0	26	70	5.0
Wo------------------------ Woodson	70	35	5.0	28	65	5.0
Ws------------------------ Woodson	70	35	5.0	28	65	5.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Bc: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	10
Bd*, Bh*:					
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	10
Collinsville	Shallow Sandstone	Favorable	4,500	Little bluestem	30
		Normal	3,700	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Bo*, Bs*:					
Bolivar	Savannah	Favorable	5,000	Big bluestem	25
		Normal	3,700	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Post oak	10
				Switchgrass	5
				Blackjack oak	5
Hector	Shallow Savannah	Favorable	3,500	Big bluestem	20
		Normal	2,500	Little bluestem	20
		Unfavorable	1,500	Indiangrass	10
				Post oak	10
				Switchgrass	5
				Blackjack oak	5
Cm*:					
Clareson	Shallow Flats	Favorable	5,000	Little bluestem	30
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	10
				Switchgrass	5
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Dc: Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5
Dn*:					
Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Dn*:					
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	10
Ea*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Lebo	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	5
Ec*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	25
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Lula	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	10
Ke Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Le Leanna	Clay Lowland	Favorable	10,000	Prairie cordgrass	35
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Eastern gamagrass	10
				Indiangrass	10
				Switchgrass	10
				Sedge	5
Ln*:					
Lebo	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	5
Rock outcrop.					

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Lo------------------ Lula	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	15
				Switchgrass-------------------	10
Mb------------------ Mason	Loamy Lowland-----------------	Favorable	10,000	Big bluestem------------------	30
		Normal	9,000	Indiangrass-------------------	20
		Unfavorable	7,000	Switchgrass-------------------	10
				Eastern gamagrass-------------	10
				Prairie cordgrass-------------	5
Oe*:					
Olpe----------------	Loamy Upland------------------	Favorable	6,500	Big bluestem------------------	30
		Normal	5,000	Little bluestem---------------	20
		Unfavorable	4,000	Indiangrass-------------------	15
				Switchgrass-------------------	10
				Tall dropseed-----------------	5
Kenoma--------------	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	25
		Normal	4,500	Little bluestem---------------	25
		Unfavorable	2,500	Indiangrass-------------------	15
				Switchgrass-------------------	10
				Tall dropseed-----------------	5
				Sideoats grama----------------	5
Os, Ov-------------- Osage	Clay Lowland------------------	Favorable	9,000	Prairie cordgrass-------------	40
		Normal	8,000	Switchgrass-------------------	15
		Unfavorable	6,000	Big bluestem------------------	15
				Indiangrass-------------------	5
				Eastern gamagrass-------------	5
				Sedge-------------------------	5
Sn, So-------------- Summit	Loamy Upland------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem---------------	25
		Unfavorable	4,500	Indiangrass-------------------	15
				Switchgrass-------------------	5
Vb, Vc-------------- Verdigris	Loamy Lowland-----------------	Favorable	10,000	Big bluestem------------------	40
		Normal	8,500	Indiangrass-------------------	20
		Unfavorable	6,000	Switchgrass-------------------	10
				Eastern gamagrass-------------	10
				Prairie cordgrass-------------	5
Wb------------------ Welda	Savannah----------------------	Favorable	5,500	Little bluestem---------------	25
		Normal	4,500	Big bluestem------------------	20
		Unfavorable	3,500	Post oak----------------------	10
				Indiangrass-------------------	10
				Switchgrass-------------------	5
Wo, Ws-------------- Woodson	Clay Upland-------------------	Favorable	6,000	Big bluestem------------------	30
		Normal	4,500	Little bluestem---------------	25
		Unfavorable	2,500	Indiangrass-------------------	15
				Switchgrass-------------------	10

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
Bo*, Bs*:								
Bolivar	4o	Slight	Slight	Slight	Slight	White oak	57	Eastern white pine, green ash, shortleaf pine.
						Black oak	60	
						Northern red oak	60	
						Black walnut	50	
						Post oak	45	
Hector	5d	Slight	Slight	Moderate	Slight	Shortleaf pine	50	Shortleaf pine, loblolly pine, eastern redcedar.
						Post oak	30	
						Shagbark hickory	45	
Ea*:								
Eram.								
Lebo	5o	Slight	Slight	Slight	Slight	White oak	50	White oak, green ash.
						Shagbark hickory	50	
						Black walnut	50	
						Chinkapin oak	50	
Le: Leanna	3o	Slight	Slight	Slight	Slight	Pin oak	80	Pecan, green ash, American sycamore, eastern cottonwood.
						Eastern cottonwood	85	
						Pecan	50	
						Common hackberry	60	
						Green ash	75	
Ln*:								
Lebo	5x	Slight	Moderate	Slight	Slight	White oak	50	White oak, green ash.
						Shagbark hickory	50	
						Black walnut	50	
						Chinkapin oak	50	
Rock outcrop.								
Mb: Mason	3o	Slight	Slight	Slight	Moderate	Eastern cottonwood	90	Bur oak, green ash, black walnut, pecan.
						Northern red oak	65	
						Green ash	75	
						Black walnut	70	
Os, Ov: Osage	4w	Slight	Moderate	Moderate	Severe	Pin oak	75	Pin oak, pecan, common hackberry, green ash.
						Pecan	50	
						Eastern cottonwood	65	
						Green ash	70	
Vb, Vc: Verdigris	3o	Slight	Slight	Slight	Slight	Eastern cottonwood	87	Eastern cottonwood, American sycamore, black walnut, bur oak, pecan.
						Bur oak	65	
						Common hackberry	69	
						Black walnut	70	
						Silver maple	61	
						Green ash	60	
						White oak	56	
Wb: Welda	4o	Slight	Slight	Slight	Slight	Black walnut	55	Green ash, common hackberry, white oak.
						Common hackberry	60	
						White oak	51	
						Green ash	60	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Bc: Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry, honeylocust.	Austrian pine, Scotch pine.	---
Bd*, Bh*: Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry, honeylocust.	Austrian pine, Scotch pine.	---
Collinsville	Fragrant sumac	Flowering dogwood	Eastern redcedar, eastern redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Bo*, Bs*: Bolivar	Silky dogwood	Amur honeysuckle, autumn-olive.	Eastern redcedar, Amur maple, Russian-olive, black locust.	Green ash, Austrian pine, eastern white pine, Scotch pine, ponderosa pine.	---
Hector	Fragrant sumac	Flowering dogwood	Eastern redcedar, eastern redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Cm*: Clareson	Fragrant sumac, Peking cotoneaster.	Flowering dogwood, Amur maple, eastern redbud.	Eastern redcedar, green ash, common hackberry, bur oak, northern red oak, honeylocust.	Siberian elm	---
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Dc: Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Dn*, Do*: Dennis	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry, honeylocust.	Austrian pine, Scotch pine.	---

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ea*:					
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Lebo	Amur honeysuckle	Autumn-olive, Manchurian crabapple, Russian-olive.	Eastern redcedar, Russian mulberry, green ash, common hackberry.	Austrian pine, honeylocust, Scotch pine.	---
Ec*:					
Eram	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Lula	American plum, fragrant sumac, Peking cotoneaster, lilac.	---	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Ke Kenoma	Lilac, fragrant sumac, American plum, Peking cotoneaster.	Eastern redcedar	Flowering dogwood, common hackberry, pin oak, Russian mulberry, eastern redcedar, green ash.	Austrian pine, Siberian elm, honeylocust.	---
Le Leanna	American plum, redosier dogwood.	Common chokecherry, autumn-olive, eastern redbud.	Eastern redcedar	Green ash, Russian mulberry, honeylocust, golden willow.	Pin oak, pecan, eastern cottonwood.
Ln*:					
Lebo	Amur honeysuckle, common chokecherry.	Autumn-olive, Manchurian crabapple, Russian-olive.	Eastern redcedar, Russian mulberry, green ash, common hackberry.	Austrian pine, honeylocust, Scotch pine.	---
Rock outcrop.					
Lo Lula	American plum, fragrant sumac, Peking cotoneaster, lilac.	Amur maple	Flowering dogwood, Russian mulberry, common hackberry, eastern redcedar, green ash.	Honeylocust, Austrian pine, Scotch pine.	---
Mb Mason	Fragrant sumac	American plum, Peking cotoneaster.	Russian mulberry	Austrian pine, honeylocust, green ash, pin oak, Scotch pine, common hackberry.	Pecan, silver maple.
Oe*:					
Olpe	Fragrant sumac	Flowering dogwood	Eastern redcedar, eastern redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Kenoma	Lilac, fragrant sumac, American plum, Peking cotoneaster.	---	Common hackberry, pin oak, flowering dogwood, Russian mulberry, eastern redcedar, green ash.	Austrian pine, Siberian elm, honeylocust.	---

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Os, Ov: Osage	American plum, redosier dogwood.	Autumn-olive, common chokecherry.	Eastern redcedar, eastern redbud.	Russian-olive, green ash, honeylocust, golden willow.	Silver maple, eastern cottonwood.
Pt*. Pits					
Sn, So: Summit	Lilac, American plum, common chokecherry, fragrant sumac.	Autumn-olive	Eastern redcedar, pin oak, common hackberry, Russian-olive.	Green ash, honeylocust, Austrian pine.	---
Vb, Vc: Verdigris	Fragrant sumac, redosier dogwood.	American plum, Peking cotoneaster.	Eastern redcedar, Russian mulberry.	Austrian pine, honeylocust, green ash, Scotch pine, common hackberry.	Silver maple.
Wb: Welda	Fragrant sumac, common chokecherry.	Amur maple, autumn-olive.	Green ash, common hackberry, eastern redcedar, honeylocust, Russian mulberry.	Pin oak, Siberian elm, Austrian pine.	---
Wo, Ws: Woodson	Fragrant sumac, lilac.	Russian-olive, autumn-olive, common chokecherry.	Flowering dogwood, common hackberry, eastern redcedar, green ash.	Austrian pine, Scotch pine, honeylocust.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bc: Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Bd*:				
Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones.	Slight.
Bh*:				
Bates	Slight	Slight	Severe: slope.	Slight.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Bo*:				
Bolivar	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Bs*:				
Bolivar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.
Cm*:				
Clareson	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Moderate: percs slowly.	Slight.
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Dc: Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Dn*, Do*:				
Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ea*:				
Eram	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Lebo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Ec*:				
Eram	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, small stones, wetness.	Severe: erodes easily.
Lula	Slight	Slight	Moderate: slope.	Severe: erodes easily.
Ke Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
Le Leanna	Severe: floods, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.
Ln*:				
Lebo	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.
Rock outcrop.				
Lo Lula	Slight	Slight	Slight	Severe: erodes easily.
Mb Mason	Severe: floods.	Moderate: percs slowly.	Moderate: percs slowly.	Severe: erodes easily.
Oe*:				
Olpe	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones.	Severe: erodes easily.
Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
Os Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Ov Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pt*. Pits				
Sn, So Summit	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Severe: erodes easily.
Vb Verdigris	Severe: floods.	Slight	Moderate: floods.	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Vc--------------------- Verdigris	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Wb--------------------- Welda	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
Wo, Ws----------------- Woodson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Bc------------------ Bates	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Bd*, Bh*:										
Bates-------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Collinsville------	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Bo*, Bs*:										
Bolivar-----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hector------------	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Poor	Very poor.
Cm*:										
Clareson----------	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
Eram--------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Dc------------------ Dennis	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Dn*, Do*:										
Dennis------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Bates-------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Ea*:										
Eram--------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Lebo--------------	Poor	Poor	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Ec*:										
Eram--------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Lula--------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Ke------------------ Kenoma	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor.
Le------------------ Leanna	Fair	Good	Fair	Good	Good	Fair	Good	Fair	Good	Fair.
Ln*:										
Lebo--------------	Very poor.	Very poor.	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Rock outcrop.										
Lo------------------ Lula	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Mb----------------- Mason	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Oe*:										
Olpe--------------	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
Kenoma------------	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor.
Os----------------- Osage	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Ov----------------- Osage	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Pt*. Pits										
Sn----------------- Summit	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
So----------------- Summit	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
Vb----------------- Verdigris	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
Vc----------------- Verdigris	Poor	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
Wb----------------- Welda	Good	Good	Good	Good	Good	Very poor.	Poor	Good	Good	Very poor.
Wo----------------- Woodson	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Fair	Fair.
Ws----------------- Woodson	Fair	Good	Fair	Poor	Poor	Poor	Good	Fair	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bc: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Moderate: low strength.
Bd*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bh*:					
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Bo*:					
Bolivar	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bs*:					
Bolivar	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Cm*:					
Clareson	Severe: depth to rock, large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: slope, large stones.	Severe: low strength, large stones.
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dc: Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Dn*, Do*:					
Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Ea*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ea*:					
Lebo	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Ec*:					
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Lula	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Ke: Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Le: Leanna	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.
Ln*:					
Lebo	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Rock outcrop.					
Lo: Lula	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Mb: Mason	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Oe*:					
Olpe	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Os, Ov: Osage	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.
Pt*. Pits					
Sn, So: Summit	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Vb, Vc: Verdigris	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Wb: Welda	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Wo, Ws------------ Woodson	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Bc: Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Bd*:					
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Bh*:					
Bates	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Collinsville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Bo*:					
Bolivar	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Hector	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones, thin layer.
Bs*:					
Bolivar	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Hector	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones, thin layer.
Cm*:					
Clareson	Severe: depth to rock, percs slowly, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, too clayey, large stones.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Dc: Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Dn*, Do*:					
Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ea*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Lebo	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ec*:					
Eram	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Lula	Moderate: depth to rock, percs slowly.	Moderate: seepage, depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Fair: area reclaim, too clayey, thin layer.
Ke Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Le Leanna	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
Ln*:					
Lebo	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, slope.
Rock outcrop.					
Lo Lula	Moderate: depth to rock, percs slowly.	Moderate: seepage, depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Fair: area reclaim, too clayey, thin layer.
Mb Mason	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Oe*:					
Olpe	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey, small stones.
Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Os, Ov Osage	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Sn, So Summit	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Vb, Vc: Verdigris	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Wb: Welda	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight	Poor: too clayey.
Wo, Ws: Woodson	Severe: percs slowly, wetness.	Slight	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bc: Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Bd*, Bh*:				
Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Collinsville	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Bo*, Bs*:				
Bolivar	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Hector	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Cm*:				
Clareson	Poor: area reclaim, low strength, large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones.
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Dc: Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Dn*, Do*:				
Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Ea*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Lebo	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ec*:				
Eram	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Lula	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke: Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Le: Leanna	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Ln*:				
Lebo	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Rock outcrop.				
Lo: Lula	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Mb: Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Oe*:				
Olpe	Fair: shrink-swell.	Improbable: excess fines.	Probable	Poor: small stones, area reclaim.
Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Os: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Ov: Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pt*. Pits				
Sn, So: Summit	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Vb, Vc: Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wb: Welda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Wo, Ws: Woodson	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bc: Bates	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bd*: Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock.	Slight	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Bh*: Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Collinsville	Severe: depth to rock, slope.	Slight	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Bo*: Bolivar	Moderate: seepage depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock slope.	Depth to rock	Depth to rock.
Hector	Severe: depth to rock.	Severe: thin layer, piping.	Deep to water	Droughty, depth to rock, slope.	Depth to rock	Droughty, depth to rock.
Bs*: Bolivar	Severe: slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Hector	Severe: depth to rock, slope.	Severe: thin layer, piping.	Deep to water	Droughty, depth to rock, slope.	Slope, depth to rock.	Slope, droughty, depth to rock.
Cm*: Clareson	Severe: slope.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Slope, large stones, depth to rock.	Large stones, slope, droughty.
Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Dc: Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Dn*, Do*: Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ea*:						
Eram	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Lebo	Severe: slope.	Moderate: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Ec*:						
Eram	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Lula	Moderate: seepage, depth to rock, slope.	Moderate: thin layer, piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Ke Kenoma	Slight	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Le Leanna	Slight	Severe: wetness.	Percs slowly, floods.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Ln*:						
Lebo	Severe: slope.	Moderate: thin layer, large stones.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Rock outcrop.						
Lo Lula	Moderate: seepage, depth to rock.	Moderate: thin layer, piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Mb Mason	Slight	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Oe*:						
Olpe	Moderate: slope.	Slight	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Kenoma	Moderate: slope.	Severe: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Os Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, floods.	Wetness	Wetness, percs slowly.	Wetness, percs slowly.
Ov Osage	Slight	Severe: hard to pack, wetness.	Percs slowly, floods.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pt*. Pits						
Sn Summit	Slight	Severe: hard to pack.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
So Summit	Moderate: slope.	Severe: hard to pack.	Percs slowly, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
Vb, Vc Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Floods	Favorable	Favorable.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Wb----------------- Welda	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope----------	Favorable------	Favorable.
Wo, Ws------------ Woodson	Slight---------	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Percs slowly, wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Bc----------------- Bates	0-19	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	19-34	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bd*, Bh*: Bates------------	0-19	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	19-34	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville-----	0-11	Loam-------------	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<30	NP-10
	11-17	Fine sandy loam, loam, channery loam.	SM, SC, ML, CL	A-4	3-40	80-100	60-100	60-95	36-75	<30	NP-10
	17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bo*, Bs*: Bolivar----------	0-13	Loam-------------	ML	A-4	0	100	90-100	70-95	55-75	20-30	NP-5
	13-28	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	28-34	Channery sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	5-20	70-95	70-95	60-90	36-60	25-35	5-15
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Hector-----------	0-9	Loam-------------	SM, ML, SM-SC, CL-ML	A-4, A-2	0	80-100	80-100	80-100	30-65	<30	NP-7
	9-18	Fine sandy loam, gravelly fine sandy loam, loam.	SM, ML, GM, GM-GC	A-4, A-2	0-15	55-100	55-100	45-100	30-65	<30	NP-7
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cm*: Clareson---------	0-7	Silty clay loam	CL	A-4, A-6	0-25	90-100	90-100	85-95	85-95	30-40	8-18
	7-15	Silty clay loam, flaggy silty clay loam.	CL	A-6, A-7	0-65	90-100	90-100	85-95	85-95	35-45	11-20
	15-26	Flaggy silty clay, flaggy silty clay loam.	CL, CH	A-7	50-85	85-100	85-100	80-95	80-95	41-60	18-35
	26	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Eram-------------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	7-38	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	38	Weathered bedrock	---	---	---	---	---	---	---	---	---
Dc----------------- Dennis	0-10	Silt loam---------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-15	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	15-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Dn*:											
Dennis----------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-15	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	15-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Bates-----------	0-19	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-1000	80-100	55-90	20-40	3-15
	19-34	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Do*:											
Dennis----------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	10-15	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	15-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Bates-----------	0-6	Clay loam--------	CL	A-6, A-7	0	90-100	85-100	80-100	60-85	35-45	15-20
	6-30	Loam, clay loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6, A-7	0	85-100	85-100	80-100	45-85	25-45	3-20
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ea*:											
Eram------------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	7-38	Silty clay, silty clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	38	Weathered bedrock	---	---	---	---	---	---	---	---	---
Lebo------------	0-14	Silty clay loam	CL	A-6, A-7-6	0-5	95-100	90-100	90-100	80-95	35-50	15-25
	14-28	Channery silty clay loam, shaly silty clay loam, silty clay loam.	CL	A-6, A-7-6	0-5	75-95	55-95	55-85	50-80	35-50	15-25
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ec*:											
Eram------------	0-7	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	7-38	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	38	Weathered bedrock	---	---	---	---	---	---	---	---	---
Lula------------	0-7	Silt loam--------	CL, ML	A-4, A-6	0	100	100	96-100	65-97	25-40	8-20
	7-12	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	65-98	30-43	9-20
	12-44	Silty clay loam, clay loam.	CL	A-6, A-7	0	95-100	95-100	95-100	75-98	33-50	12-26
	44	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ke--------------- Kenoma	0-11	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	11-34	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	34-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Le--------------- Leanna	0-17	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	17-32	Silty clay, silty clay loam, clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-65	25-40
	32-60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-55	20-35

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
Ln*:											
Lebo	0-7	Stony silty clay loam.	CL	A-6, A-7-6	25-50	75-95	55-75	55-70	50-65	35-50	15-25
	7-12	Channery silty clay loam, shaly silty clay loam, silty clay loam.	CL	A-6, A-7-6	0-5	75-95	55-95	55-85	50-80	35-50	15-25
	12-28	Very shaly silty clay loam, very shaly silt loam.	SC	A-2-6, A-2-7	0-5	50-75	10-50	5-40	5-35	35-50	15-25
	28	Weathered bedrock	---	---	---	---	---	---	---	---	---
Rock outcrop.											
Lo: Lula	0-7	Silt loam	CL, ML	A-4, A-6	0	100	100	96-100	65-97	25-40	8-20
	7-12	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0	100	100	96-100	65-98	30-43	9-20
	12-44	Silty clay loam, clay loam.	CL	A-6, A-7	0	95-100	95-100	95-100	75-98	33-50	12-26
	44	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Mb: Mason	0-7	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	20-35	1-13
	7-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
Oe*:											
Olpe	0-16	Silty clay loam	CL	A-6, A-4	0	80-100	75-100	65-95	60-90	25-40	7-15
	16-60	Very gravelly silty clay, very gravelly clay, very gravelly clay loam.	GC, SC, GP-GC, SP-SC	A-2-7 A-7	0	30-65	10-50	10-50	10-45	40-60	25-40
Kenoma	0-11	Silt loam	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	11-34	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	34-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
Os: Osage	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	40-50	16-25
	14-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-80	30-55
Ov: Osage	0-17	Silty clay	CH	A-7-6	0	100	100	100	95-100	50-75	30-55
	17-60	Silty clay, clay, silty clay loam.	CH	A-7-6	0	100	100	100	95-100	50-80	30-55
Pt*. Pits											
Sn, So: Summit	0-6	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	96-100	80-99	35-60	11-30
	6-14	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7, A-6	0	100	100	96-100	80-99	37-65	15-35
	14-57	Clay, silty clay	CH, MH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
	57-60	Clay, silty clay, silty clay loam.	CH, MH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
Vb, Vc: Verdigris	0-16	Silt loam	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	16-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Wb---------------- Welda	0-11	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-35	5-15
	11-50	Silty clay loam, silty clay.	CL	A-7-6, A-6	0	100	100	95-100	85-100	38-50	20-30
	50-60	Silty clay loam, silt loam.	ML, CL	A-6, A-4, A-7-6	0	100	100	90-100	75-100	30-45	7-20
Wo, Ws------------ Woodson	0-12	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	12-30	Silty clay, clay	CH	A-7-6	0	100	95-100	95-100	90-100	50-65	30-45
	30-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	95-100	95-100	90-100	45-65	20-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Bc-------------- Bates	0-19	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	19-34	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	34	---	---	---	---	---	---	----------	----			
Bd*, Bh*:												
Bates-----------	0-19	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	19-34	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	34	---	---	---	---	---	---	----------	----			
Collinsville----	0-11	5-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low-------	0.32	2	5	1-2
	11-17	5-20	1.30-1.65	2.0-6.0	0.09-0.13	5.1-6.5	<2	Low-------	0.20			
	17	---	---	---	---	---	---	----------	----			
Bo*, Bs*:												
Bolivar---------	0-13	15-27	1.20-1.40	0.6-2.0	0.19-0.21	5.1-6.0	<2	Low-------	0.32	4	5	.5-3
	13-28	20-35	1.30-1.50	0.6-2.0	0.12-0.16	4.5-6.0	<2	Moderate	0.32			
	28-34	25-32	1.35-1.55	0.6-2.0	0.09-0.12	4.5-6.0	<2	Low-------	0.32			
	34	---	---	---	---	---	---	----------	----			
Hector----------	0-9	5-20	1.30-1.60	2.0-6.0	0.10-0.14	5.1-6.5	<2	Low-------	0.17	1	5	---
	9-18	10-25	1.30-1.60	2.0-6.0	0.08-0.15	4.5-5.5	<2	Low-------	0.17			
	18	---	---	---	---	---	---	----------	----			
Cm*:												
Clareson--------	0-7	15-30	1.25-1.35	0.6-2.0	0.16-0.22	5.6-7.3	<2	Moderate	0.32	2	7	---
	7-15	27-40	1.30-1.40	0.2-2.0	0.09-0.21	5.6-7.3	<2	Moderate	0.24			
	15-26	35-50	1.35-1.45	0.06-0.6	0.04-0.07	5.6-7.3	<2	Moderate	0.24			
	26	---	---	---	---	---	---	----------	----			
Eram------------	0-7	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	7-38	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	38	---	---	---	---	---	---	----------	----			
Dc-------------- Dennis	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	10-15	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	15-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Dn*:												
Dennis----------	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	10-15	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	15-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Bates-----------	0-19	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low-------	0.28	4	5	1-4
	19-34	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	34	---	---	---	---	---	---	----------	----			
Do*:												
Dennis----------	0-10	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low-------	0.43	5	6	1-3
	10-15	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	15-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High------	0.37			
Bates-----------	0-6	27-35	1.40-1.50	0.6-2.0	0.17-0.19	5.1-6.5	<2	Low-------	0.28	4	6	1-2
	6-30	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low-------	0.28			
	30	---	---	---	---	---	---	----------	----			
Ea*:												
Eram------------	0-7	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	7-38	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	38	---	---	---	---	---	---	----------	----			
Lebo------------	0-14	22-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	4	7	---
	14-28	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	28	---	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Ec*:												
Eram------------	0-7	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	7-38	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High------	0.37			
	38	---	---	---	---	---	---	----------	----			
Lula------------	0-7	18-27	1.30-1.50	0.6-2.0	0.16-0.20	5.6-6.5	<2	Low-------	0.37	3	6	1-3
	7-12	24-35	1.40-1.70	0.6-2.0	0.16-0.20	5.6-6.5	<2	Moderate	0.37			
	12-44	27-35	1.45-1.70	0.6-2.0	0.16-0.20	5.1-7.3	<2	Moderate	0.32			
	44	---	---	---	---	---	---	----------	----			
Ke---------------- Kenoma	0-11	18-29	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low-------	0.43	4	6	2-4
	11-34	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	34-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Le---------------- Leanna	0-17	15-30	1.25-1.35	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low-------	0.37	5	6	1-4
	17-32	35-50	1.35-1.50	<0.06	0.11-0.18	5.1-6.5	<2	High------	0.37			
	32-60	27-45	1.35-1.45	0.06-0.2	0.11-0.20	5.6-7.3	<2	High------	0.37			
Ln*:												
Lebo------------	0-7	22-35	1.35-1.45	0.6-2.0	0.07-0.18	5.6-7.8	<2	Moderate	0.24	4	8	---
	7-12	22-35	1.40-1.50	0.6-2.0	0.15-0.18	5.6-7.8	<2	Moderate	0.24			
	12-28	22-35	1.45-1.65	0.6-2.0	0.07-0.10	5.6-7.8	<2	Moderate	0.24			
	28	---	---	---	---	---	---	----------	----			
Rock outcrop.												
Lo---------------- Lula	0-7	18-27	1.30-1.50	0.6-2.0	0.16-0.20	5.6-6.5	<2	Low-------	0.37	3	6	1-3
	7-12	24-35	1.40-1.70	0.6-2.0	0.16-0.20	5.6-6.5	<2	Moderate	0.37			
	12-44	27-35	1.45-1.70	0.6-2.0	0.16-0.20	5.1-7.3	<2	Moderate	0.32			
	44	---	---	---	---	---	---	----------	----			
Mb---------------- Mason	0-7	20-30	1.30-1.60	0.6-2.0	0.16-0.20	5.1-7.3	<2	Low-------	0.37	5	6	1-3
	7-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	4.5-7.8	<2	Moderate	0.37			
Oe*:												
Olpe------------	0-16	15-30	1.25-1.35	0.6-2.0	0.20-0.23	5.1-6.5	<2	Low-------	0.43	3	6	---
	16-60	35-50	1.35-1.45	0.06-0.2	0.04-0.10	5.6-7.8	<2	Moderate	0.24			
Kenoma----------	0-11	18-29	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low-------	0.43	4	6	2-4
	11-34	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High------	0.32			
	34-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High------	0.32			
Os---------------- Osage	0-14	35-40	1.45-1.65	<0.06	0.21-0.23	5.1-7.3	<2	High------	0.28	5	4	1-4
	14-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Ov---------------- Osage	0-17	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.3	<2	Very high	0.28	5	4	1-4
	17-60	35-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Pt*. Pits												
Sn, So------------ Summit	0-6	27-45	1.25-1.50	0.2-0.6	0.16-0.20	5.6-7.3	<2	Moderate	0.37	4	7	1-3
	6-14	32-45	1.35-1.65	0.2-0.6	0.10-0.18	5.6-7.3	<2	High------	0.37			
	14-57	40-60	1.35-1.60	0.06-0.2	0.10-0.18	5.6-8.4	<2	High------	0.32			
	57-60	35-55	1.40-1.65	0.06-0.2	0.10-0.18	6.6-8.4	<2	High------	0.32			
Vb, Vc------------ Verdigris	0-16	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low-------	0.32	5	6	2-4
	16-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Wb---------------- Welda	0-11	12-29	1.25-1.35	0.6-2.0	0.22-0.24	5.1-7.3	<2	Low-------	0.32	5	6	.5-1
	11-50	35-42	1.35-1.40	0.2-0.6	0.14-0.20	5.1-6.5	<2	Moderate	0.32			
	50-60	18-35	1.40-1.45	0.6-2.0	0.18-0.22	5.1-6.5	<2	Moderate	0.32			
Wo, Ws------------ Woodson	0-12	18-30	1.25-1.45	0.2-0.6	0.22-0.24	5.6-6.5	<2	Low-------	0.43	4	6	1-4
	12-30	40-60	1.30-1.45	<0.06	0.12-0.15	5.6-7.3	<2	High------	0.32			
	30-60	30-50	1.35-1.45	0.06-0.2	0.10-0.15	5.6-7.8	<2	High------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hard-ness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In			
Bc----------------- Bates	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Bd*, Bh*:											
Bates--------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Collinsville------	C	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Moderate.
Bo*, Bs*:											
Bolivar------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Hector-------------	D	None---------	---	---	>6.0	---	---	10-20	Hard	Low-------	Moderate.
Cm*:											
Clareson----------	C	None---------	---	---	>6.0	---	---	20-40	Hard	High------	Moderate.
Eram---------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High------	Moderate.
Dc----------------- Dennis	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High------	Moderate.
Dn*, Do*:											
Dennis------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High------	Moderate.
Bates--------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Low-------	Moderate.
Ea*:											
Eram---------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High------	Moderate.
Lebo---------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low.
Ec*:											
Eram---------------	C	None---------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High------	Moderate.
Lula---------------	B	None---------	---	---	>6.0	---	---	40-60	Hard	Moderate	Moderate.
Ke----------------- Kenoma	D	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
Le----------------- Leanna	D	Occasional	Brief to to long.	Nov-May	0.5-2.0	Perched	Dec-Jun	>60	---	High------	Moderate.
Ln*:											
Lebo---------------	B	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	Low.
Rock outcrop.											
Lo----------------- Lula	B	None---------	---	---	>6.0	---	---	40-60	Hard	Moderate	Moderate.
Mb----------------- Mason	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
Oe*:											
Olpe---------------	C	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
Kenoma------------	D	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
Os, Ov------------- Osage	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	High------	Moderate.
Pt*. Pits											

See footnote at end of table.

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In			
Sn, So----------- Summit	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High-----	Low.
Vb--------------- Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low------	Low.
Vc--------------- Verdigris	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low------	Low.
Wb--------------- Welda	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
Wo, Ws----------- Woodson	D	None--------	---	---	0.5-2.0	Perched	Dec-Apr	>60	---	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Bates---------------------	Fine-loamy, siliceous, thermic Typic Argiudolls
Bolivar-------------------	Fine-loamy, mixed, thermic Ultic Hapludalfs
Clareson------------------	Clayey-skeletal, mixed, thermic Typic Argiudolls
Collinsville--------------	Loamy, siliceous, thermic Lithic Hapludolls
Dennis--------------------	Fine, mixed, thermic Aquic Paleudolls
Eram----------------------	Fine, mixed, thermic Aquic Argiudolls
Hector--------------------	Loamy, siliceous, thermic Lithic Dystrochrepts
Kenoma--------------------	Fine, montmorillonitic, thermic Vertic Argiudolls
Leanna--------------------	Fine, mixed, thermic Typic Argialbolls
Lebo----------------------	Loamy-skeletal, mixed, thermic Typic Hapludolls
Lula*---------------------	Fine-silty, mixed, thermic Typic Argiudolls
Mason---------------------	Fine-silty, mixed, thermic Typic Argiudolls
Olpe----------------------	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Osage---------------------	Fine, montmorillonitic, thermic Vertic Haplaquolls
Summit--------------------	Fine, montmorillonitic, thermic Vertic Argiudolls
Verdigris-----------------	Fine-silty, mixed, thermic Cumulic Hapludolls
Welda*--------------------	Fine, montmorillonitic, mesic Typic Hapludalfs
Woodson-------------------	Fine, montmorillonitic, thermic Abruptic Argiaquolls

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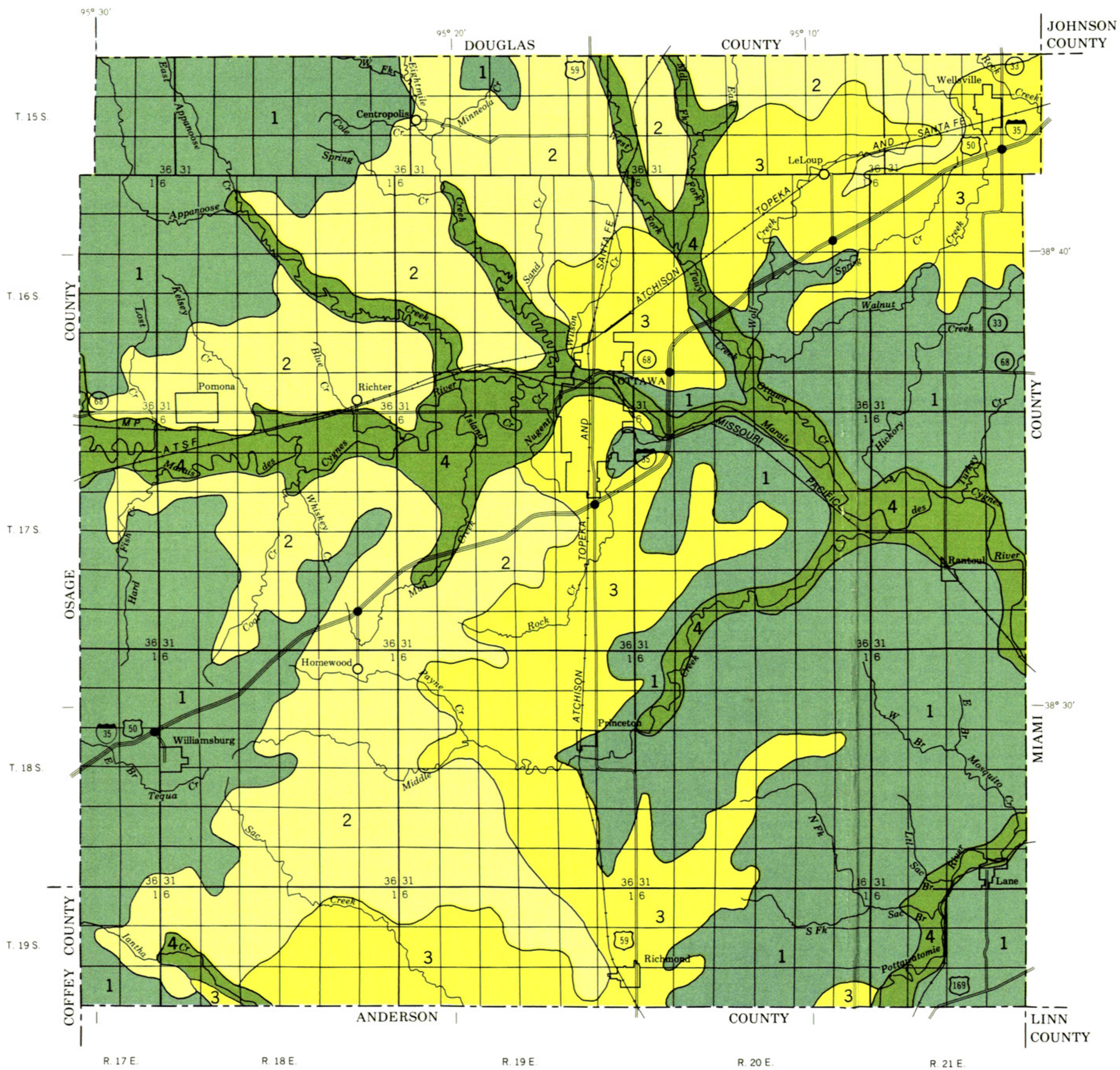
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

FRANKLIN COUNTY, KANSAS

Scale 1:190,080



SOIL LEGEND

1 Lula-Eram-Summit association: Deep and moderately deep, nearly level to strongly sloping, well drained and moderately well drained soils on uplands

2 Dennis-Bates-Woodson association: Deep and moderately deep, nearly level to moderately sloping, well drained to somewhat poorly drained soils on uplands

3 Kenoma-Woodson association: Deep, nearly level and gently sloping, moderately well drained and somewhat poorly drained soils on uplands

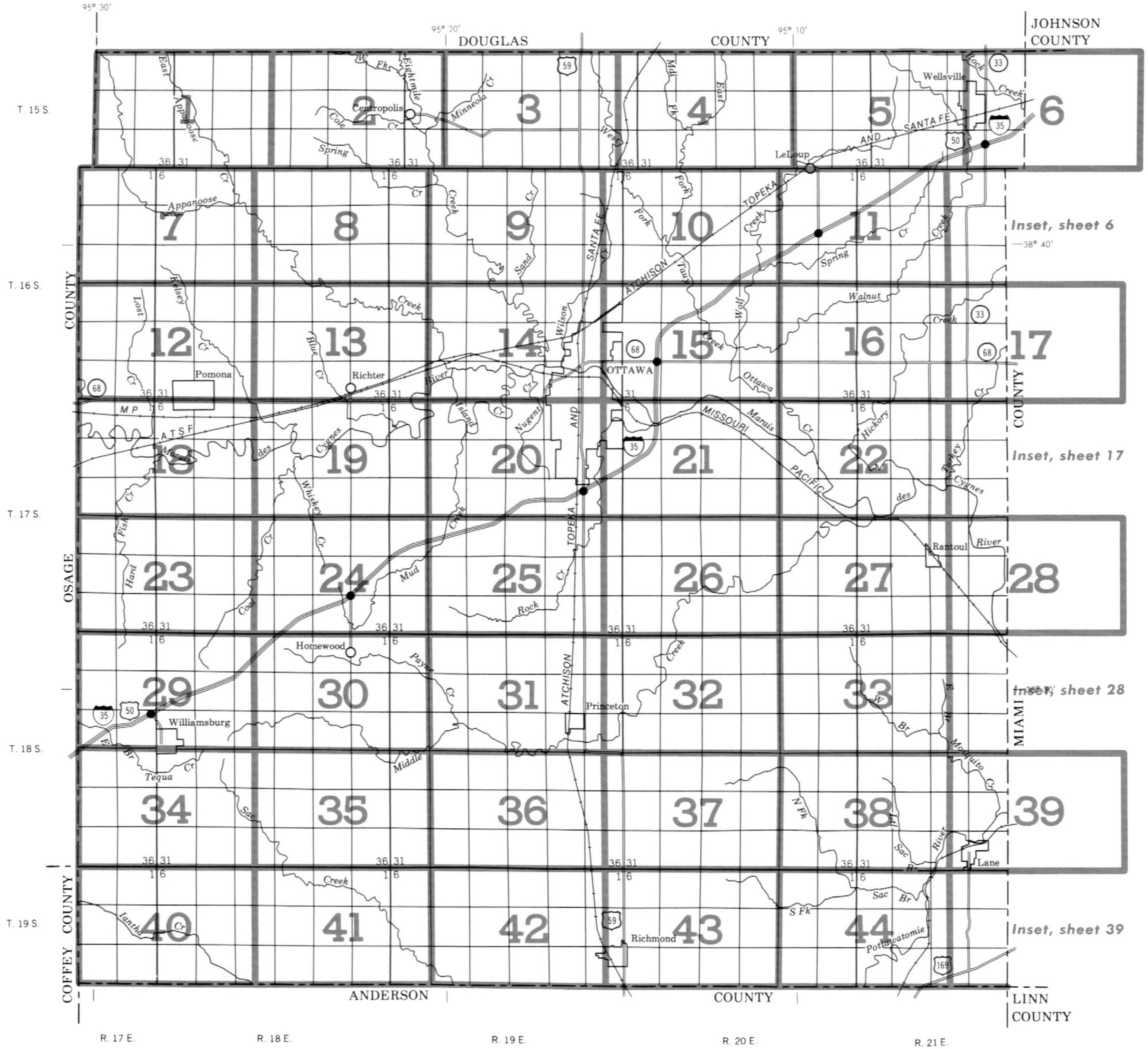
4 Verdigris-Osage association: Deep, nearly level, well drained and poorly drained soils on bottom land

Compiled 1980

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



N

INDEX TO MAP SHEETS
FRANKLIN COUNTY, KANSAS

Scale 1: 190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

Original text from each individual map sheet read:
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Bc	Bates loam, 1 to 4 percent slopes
Bd	Bates-Collinsville loams, 3 to 7 percent slopes
Bh	Bates-Collinsville loams, 7 to 12 percent slopes
Bo	Bolivar-Hector loams, 2 to 6 percent slopes
Bs	Bolivar-Hector loams, 6 to 12 percent slopes
Cm	Clareson-Eram silty clay loams, 3 to 15 percent slopes
Dc	Dennis silt loam, 2 to 5 percent slopes
Dn	Dennis-Bates complex, 2 to 6 percent slopes
Do	Dennis-Bates complex, 3 to 6 percent slopes, eroded
Ea	Eram-Lebo silty clay loams, 7 to 12 percent slopes
Ec	Eram-Lula complex, 3 to 7 percent slopes
Ke	Kenoma silt loam, 1 to 4 percent slopes
Le	Leanna silt loam
Ln	Lebo-Rock outcrop complex, 20 to 40 percent slopes
Lo	Lula silt loam, 0 to 2 percent slopes
Mb	Mason silt loam
Oe	Olpe-Kenoma complex, 1 to 5 percent slopes
Os	Osage silty clay loam
Ov	Osage silty clay
Pt	Pits, quarries
Sn	Summit silty clay loam, 1 to 3 percent slopes
So	Summit silty clay loam, 3 to 7 percent slopes
Vb	Verdigris silt loam
Vc	Verdigris silt loam, channeled
Wb	Welda silt loam, 2 to 6 percent slopes
Wo	Woodson silt loam, 0 to 1 percent slopes
Ws	Woodson silt loam, 1 to 2 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — Bh; Sn

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

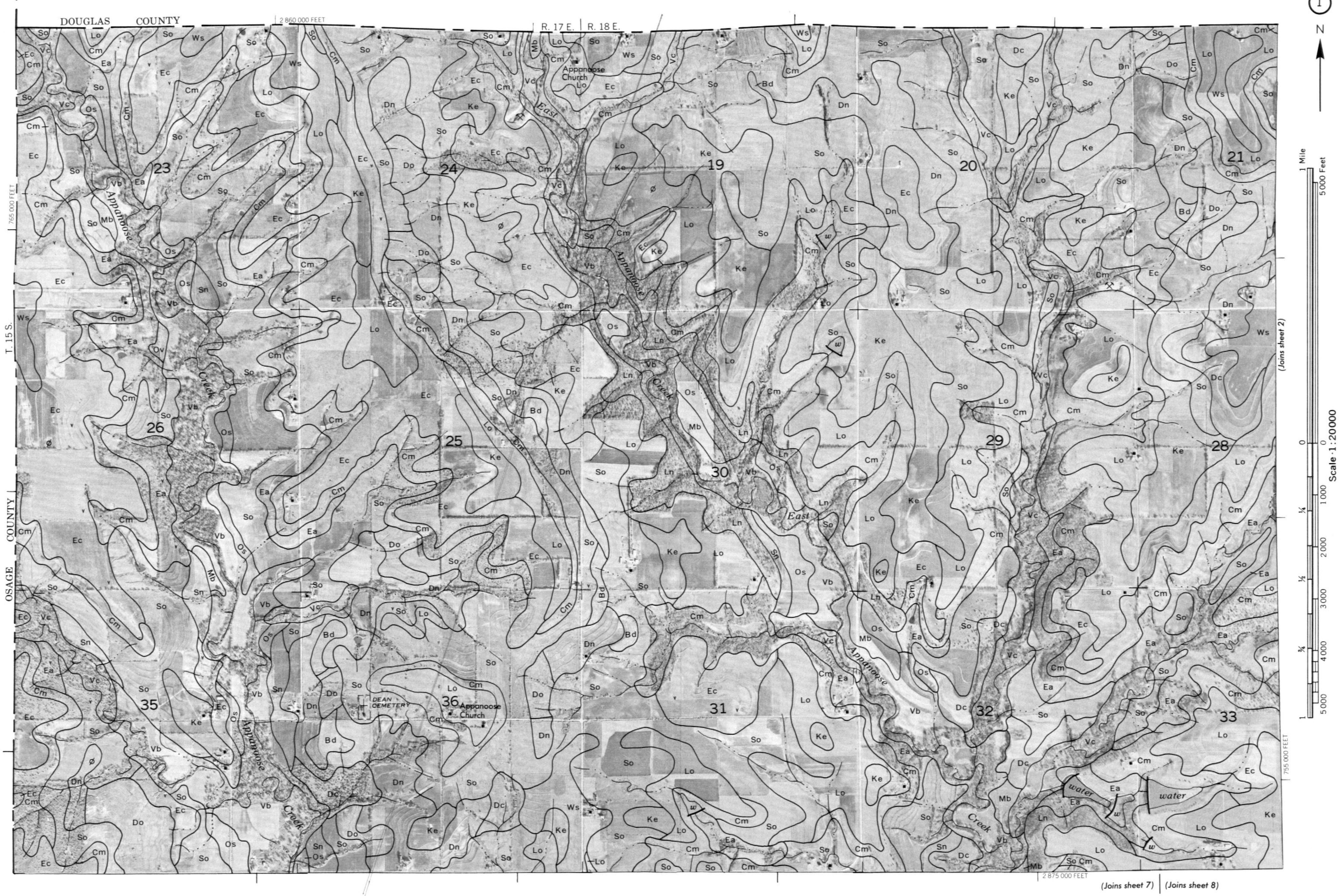
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

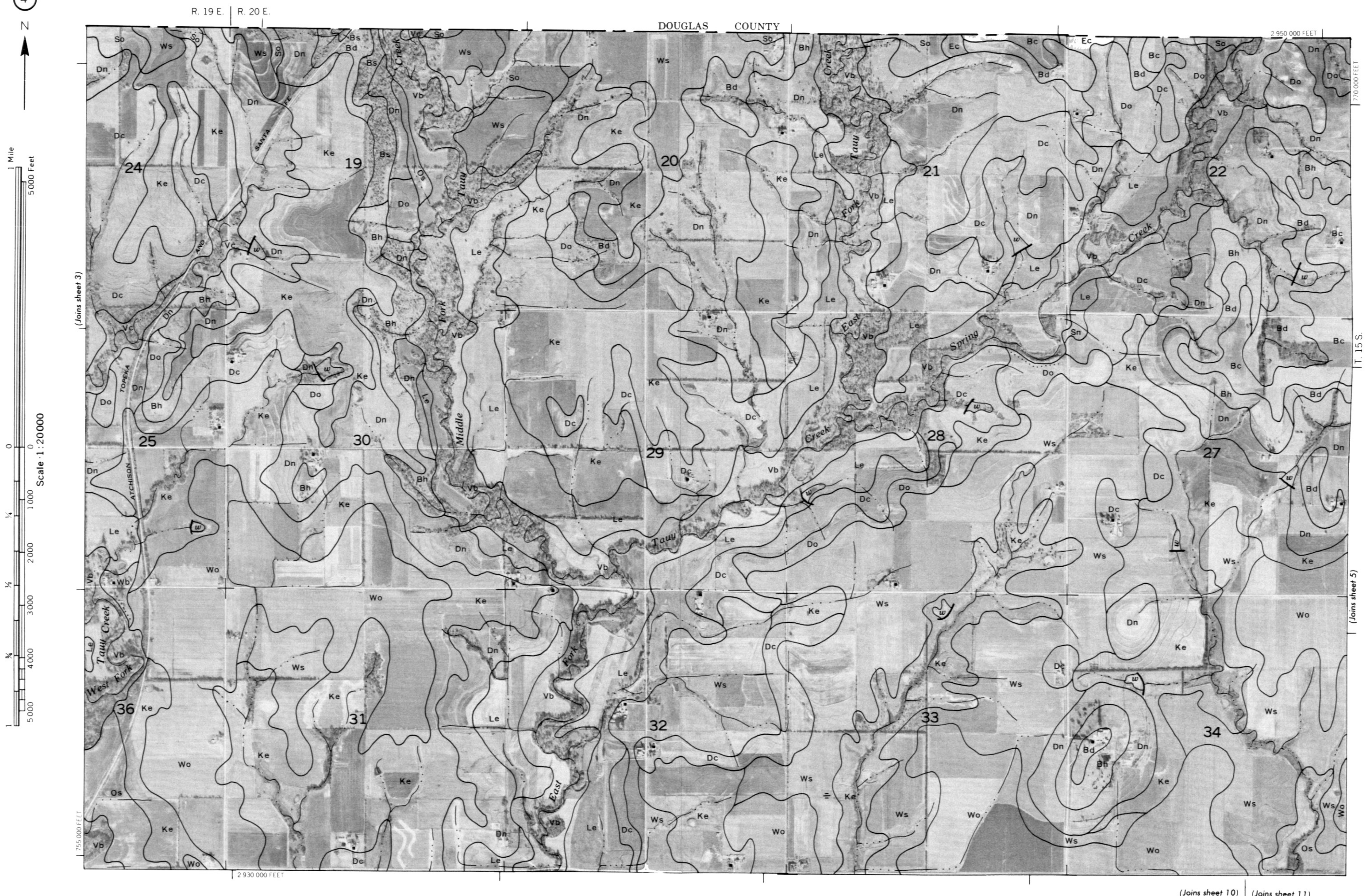
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Abandoned coal mine
- Borrow area

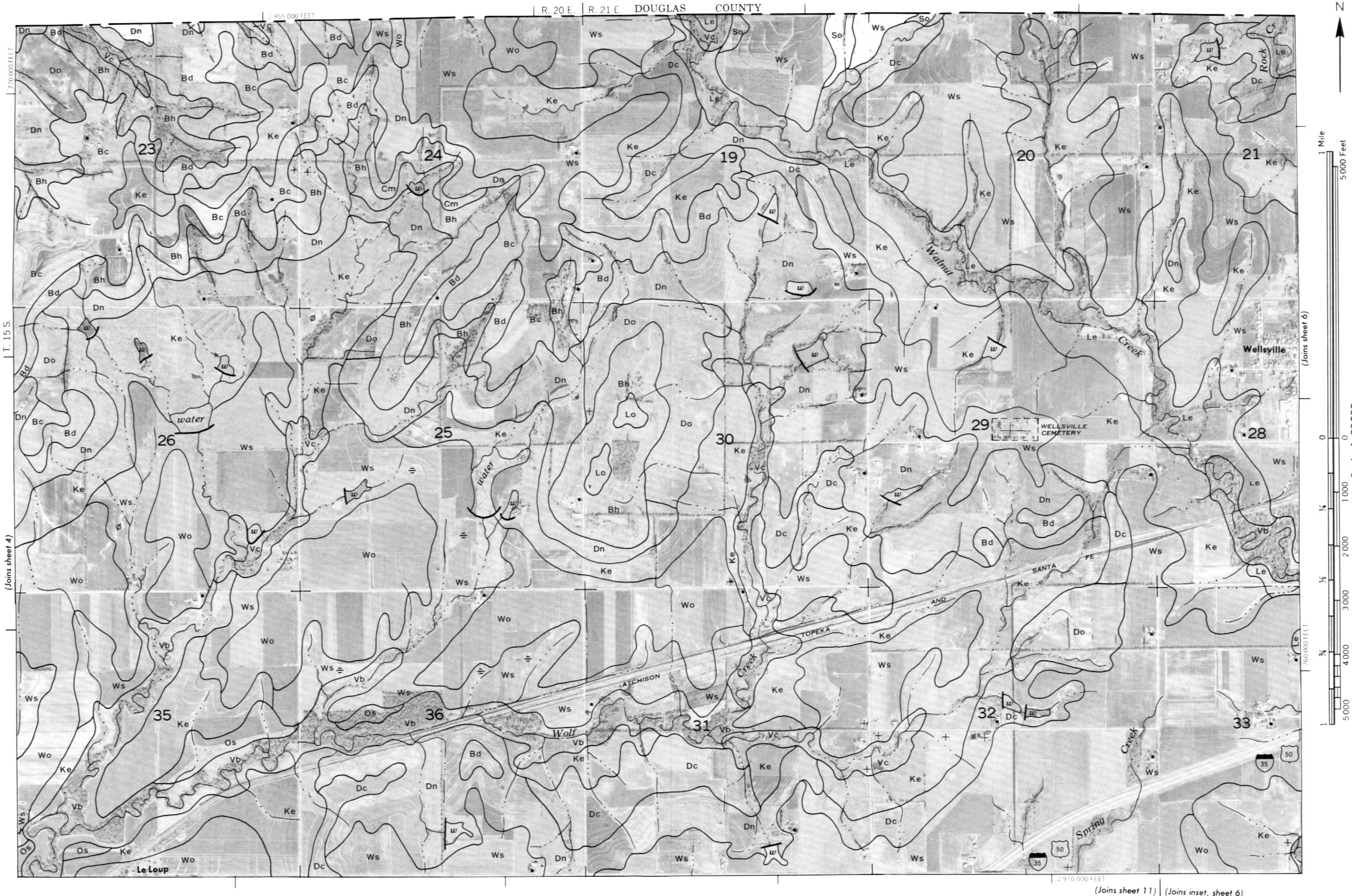

DOUGLAS COUNTY
OSAGE COUNTY
2 860 000 FEET
R. 17 E.
R. 18 E.
T. 15 S.
765 000 FEET
755 000 FEET
2 875 000 FEET
Appanoose Church
Appanoose
Creek
East
DEAN CEMETERY
Appanoose Church
water
(Joins sheet 2)
(Joins sheet 7)
(Joins sheet 8)
N
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

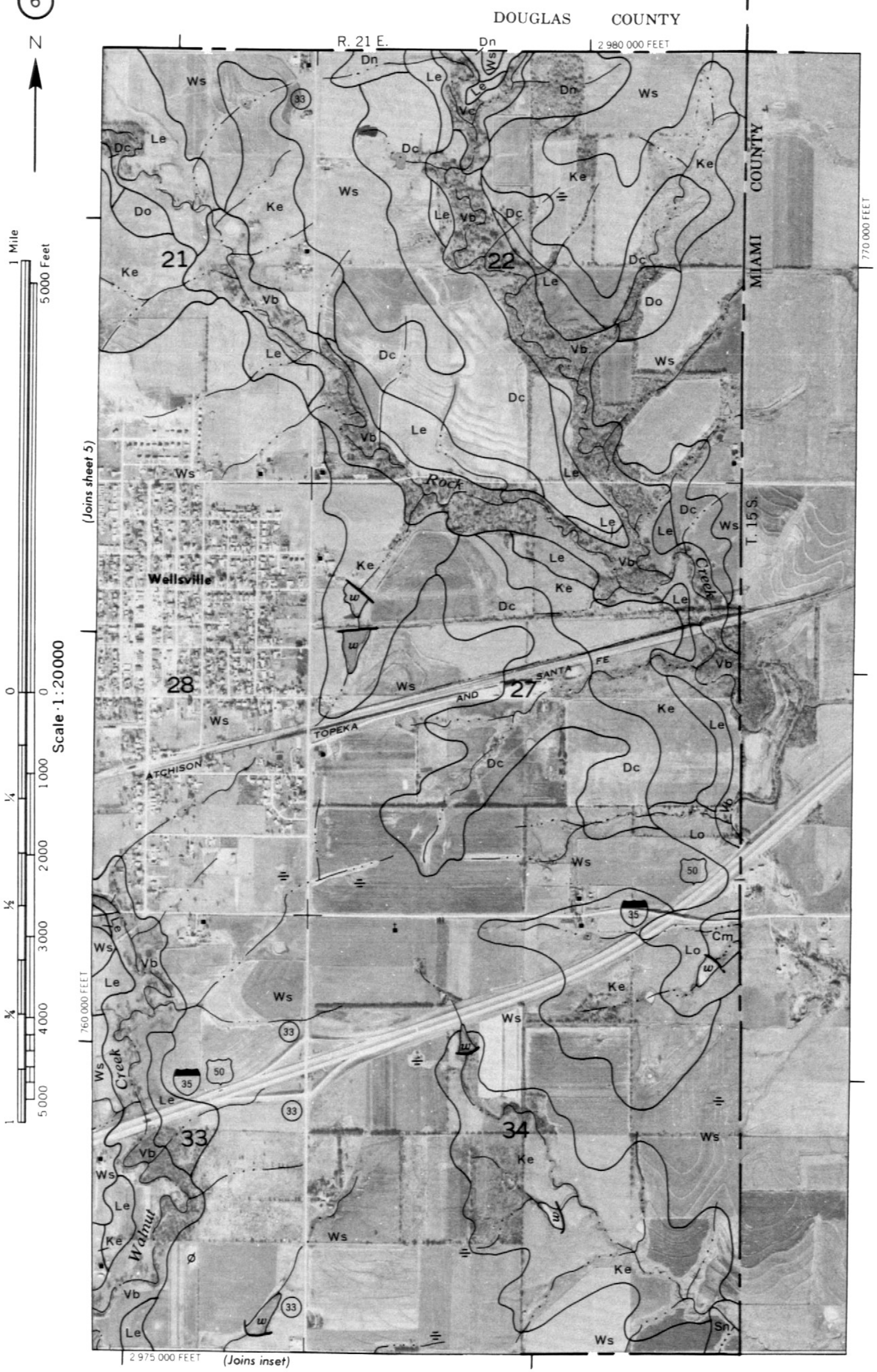

2
N
DOUGLAS COUNTY
R. 18 E.
R. 19 E.
2 900 000 FEET
765 000 FEET
T. 15 S.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
(Joins sheet 9)
2 880 000 FEET
755 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1/4
1/2
3/4
1000
2000
3000
4000
5000
West Fork Eightmile Creek
Eightmile
Cole Creek
Minneola Creek
Eightmile
Spring Creek
PLEASANT HILL CEMETERY
Eightmile Church
CENTROPOLIS CEMETERY
Centropolis
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 3

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 4

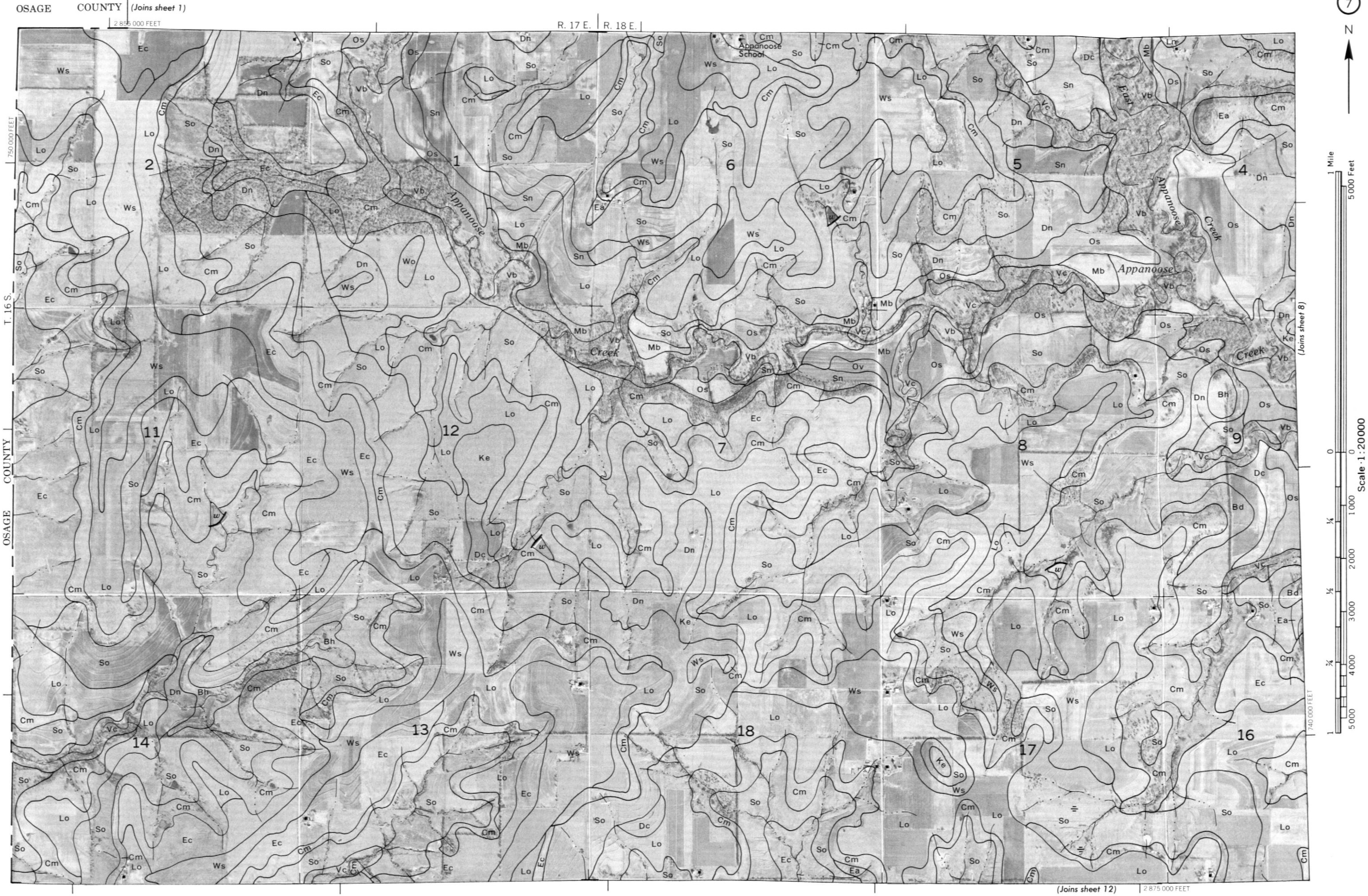



R. 20 E.
R. 21 E.
DOUGLAS COUNTY
T. 15 S.
2 955 000 FEET
770 000 FEET
760 000 FEET
2 970 000 FEET
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)
(Joins inset, sheet 6)
Wellsville
WELLSVILLE CEMETERY
Walnut Creek
Rock Cr.
Wolf Creek
Spring Creek
ATCHISON TOPEKA AND SANTA FE
Le Loup
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
N
1 Mile
5000 Feet
Scale 1:20000


6
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
DOUGLAS COUNTY
R. 21 E.
2 980 000 FEET
770 000 FEET
760 000 FEET
2 975 000 FEET
(Joins sheet 5)
(Joins inset)
MIAMI COUNTY
T. 15 S.
Wellsville
ATCHISON TOPEKA AND SANTA FE
Rock Creek
Walnut Creek
21
22
27
28
33
34


(Joins sheet 5)
(Joins lower left)
R. 21 E.
2 980 000 FEET
755 000 FEET
745 000 FEET
2 975 000 FEET
(Joins sheet 11)
(Joins sheet 17)
MIAMI COUNTY
T. 16 S.
Walnut Creek
Hickory Creek
WALNUT CREEK CEMETERY
3
4
9
10
15
16

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 7

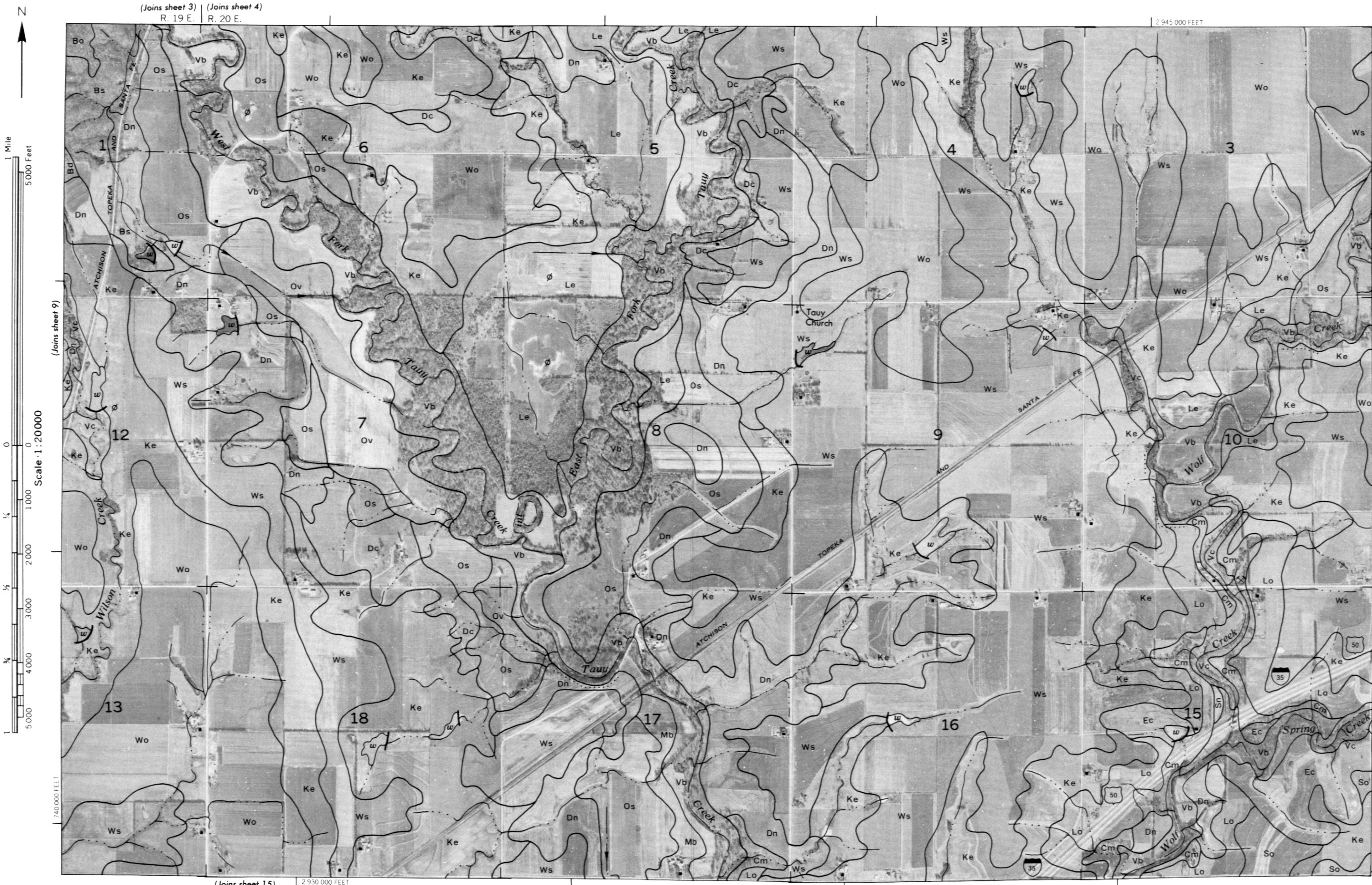



8
N
(Joins sheet 1)
(Joins sheet 2)
R. 18 E.
R. 19 E.
2 900 000 FEET
750 000 FEET
T. 16 S.
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 13)
2 880 000 FEET
740 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
Le Spring
Creek
Appanoose
Creek


(Joins sheet 2)
(Joins sheet 3)
2 905 000 FEET
R. 19 E.
T. 16 S.
750 000 FEET
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
2 925 000 FEET
740 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Eightmile
Spring Cr.
Creek
Eightmile
Sand
Creek
Wilson
Creek
ATCHISON
TOPEKA
AND
SANTA
FE
water

10

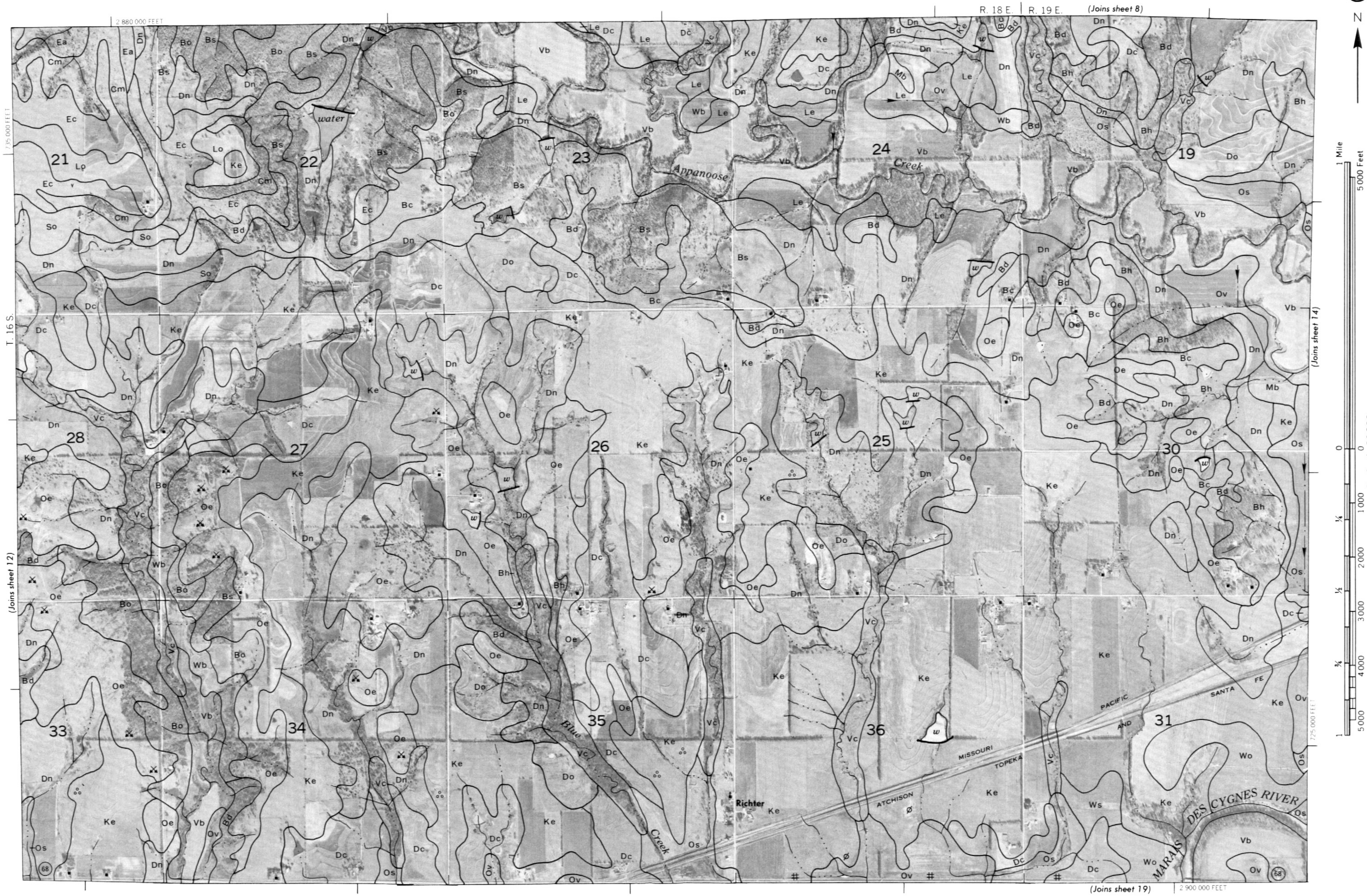
FRANKLIN COUNTY, KANSAS — SHEET NUMBER 10

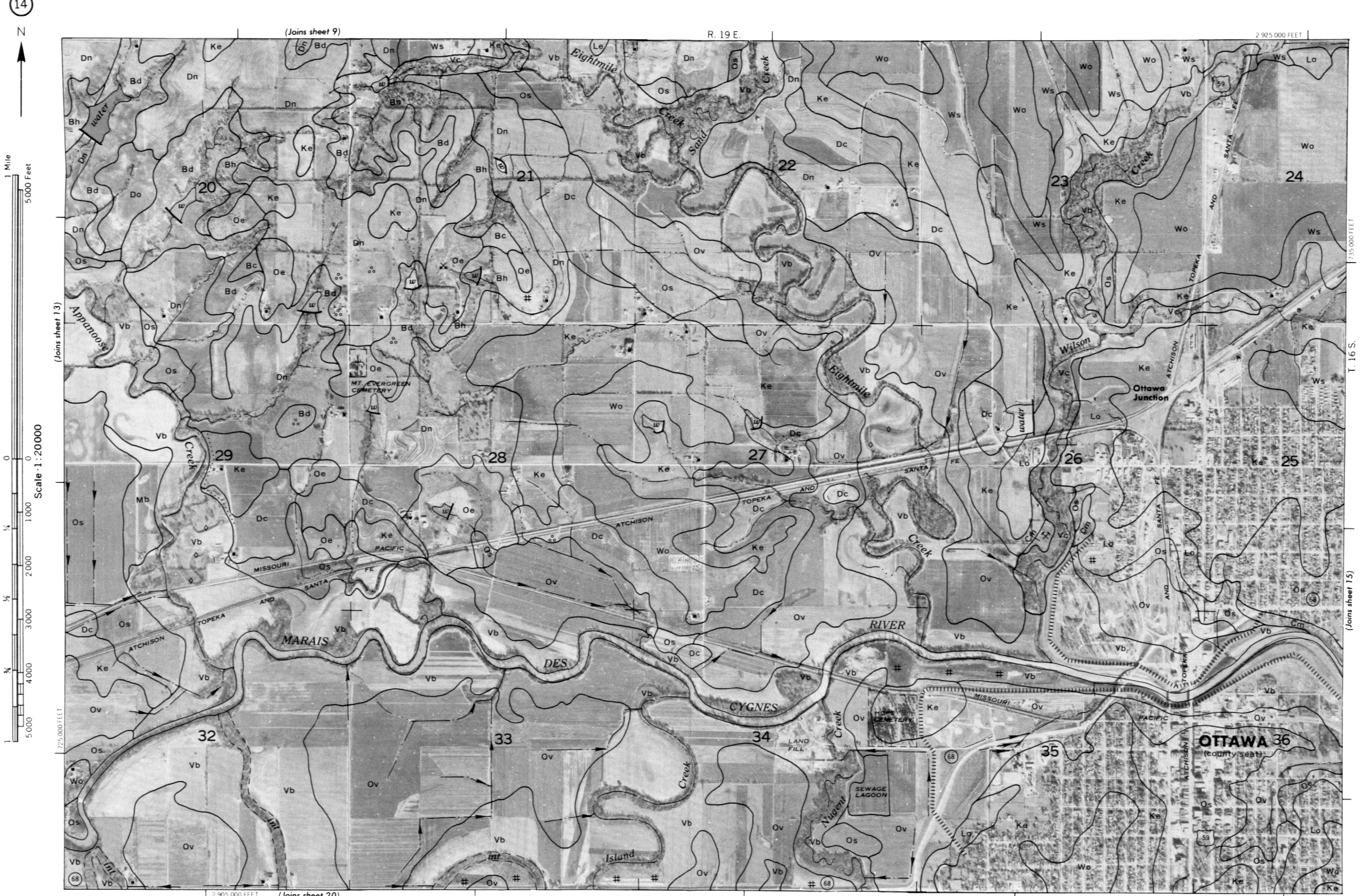


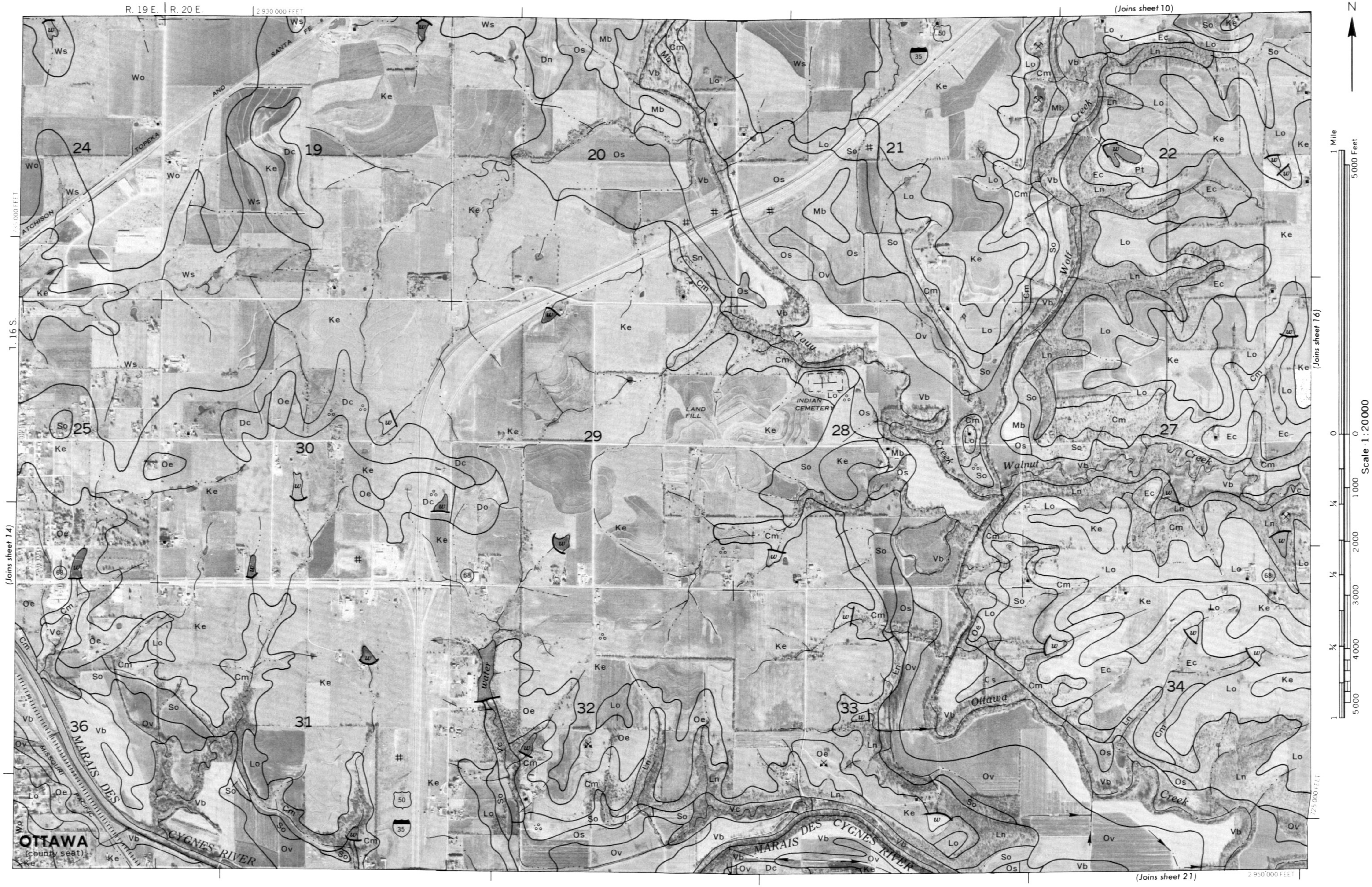

11
(Joins sheet 4)
(Joins sheet 5)
R. 20 E.
R. 21 E.
2 950 000 FEET
Le Loup
Wolf Creek
ATCHISON TOPEKA AND SANTA FE
Spring Creek
Walnut Creek
Creek
water
T. 16 S.
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 16)
745 000 FEET
2 970 000 FEET
35
50
N
1 Mile
5000 Feet
Scale 1:20000
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

12

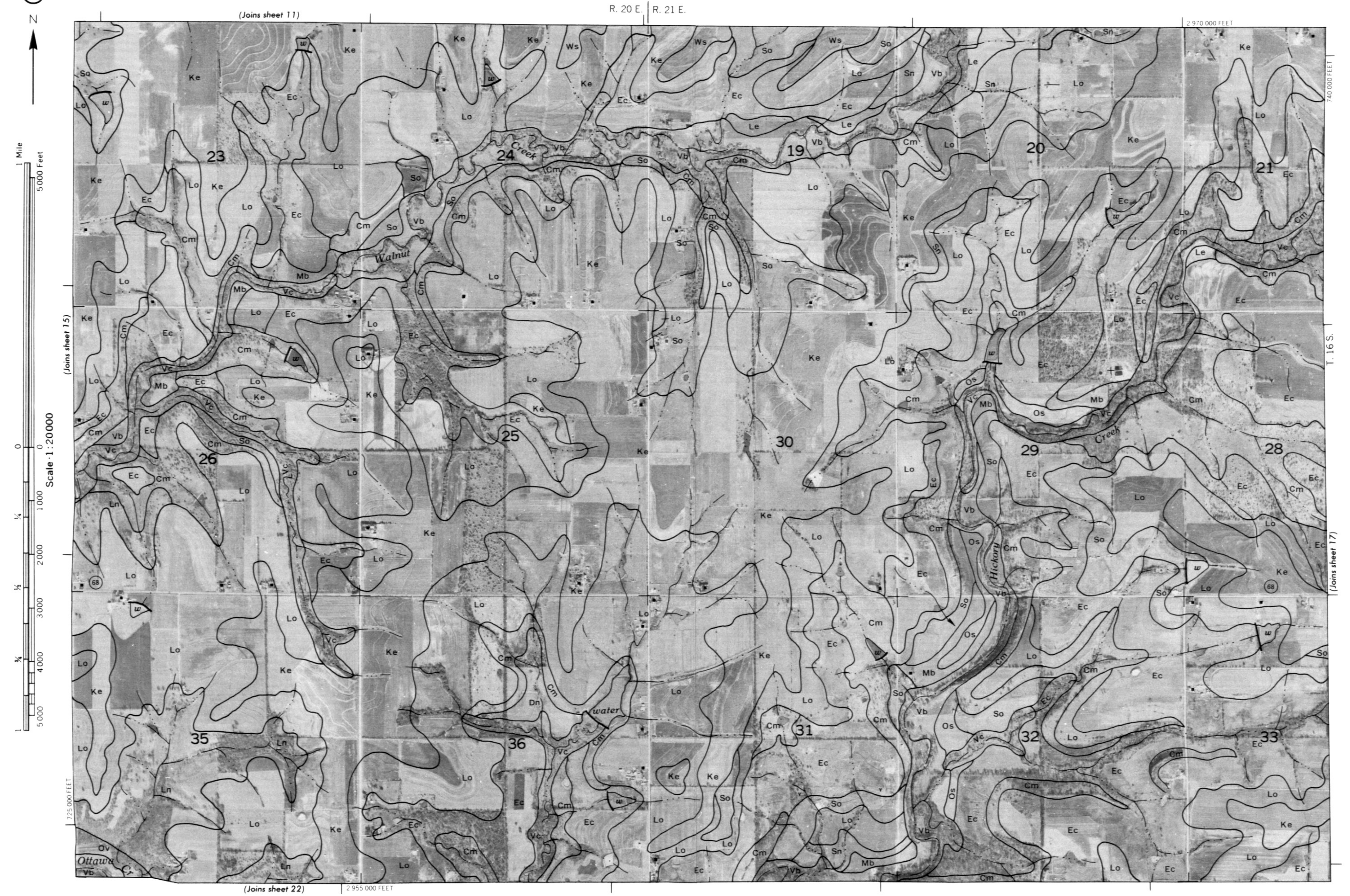
FRANKLIN COUNTY, KANSAS — SHEET NUMBER 12

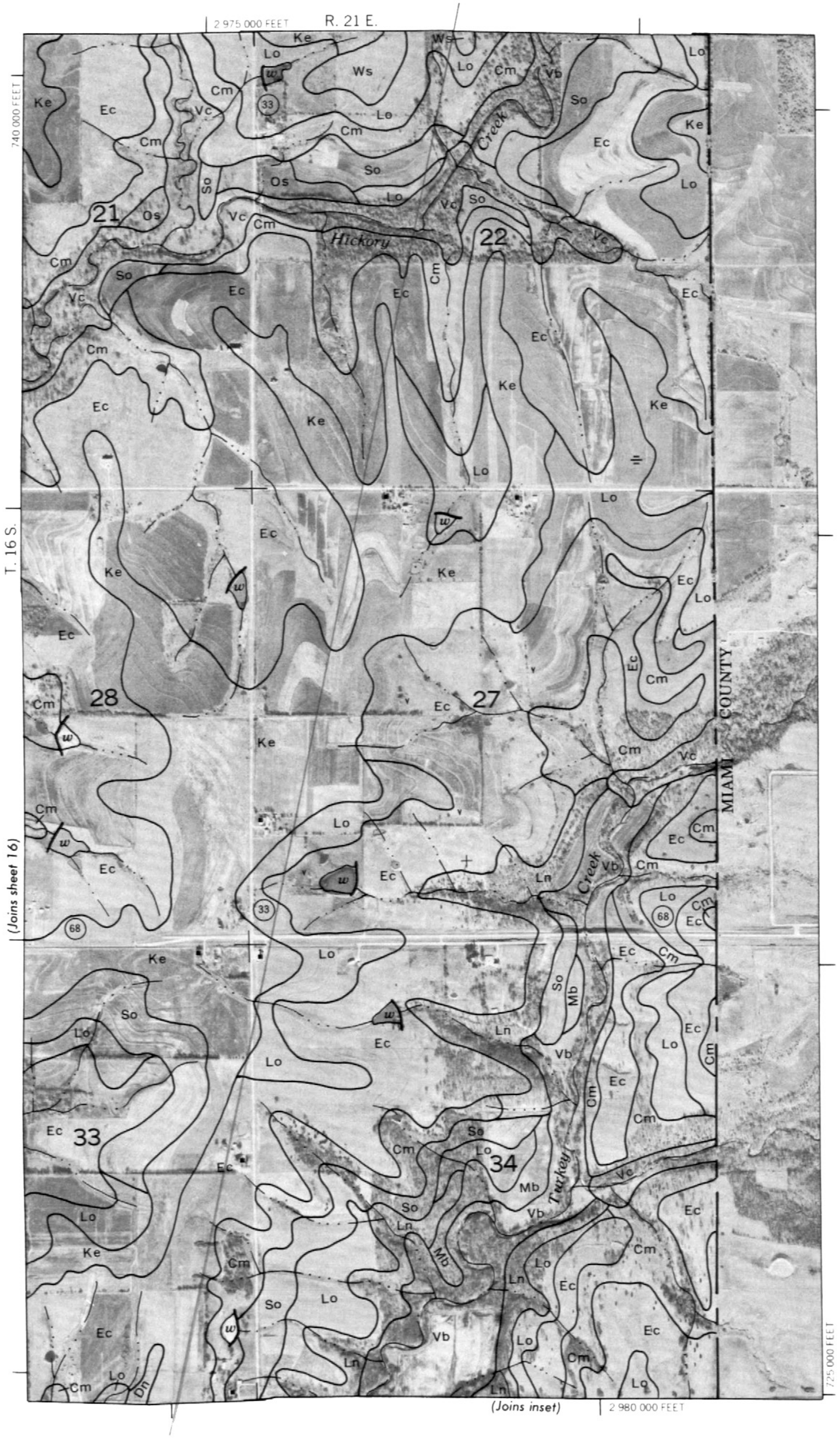

N
R. 18 E. | R. 19 E.
(Joins sheet 8)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 19)
T. 16 S.
2 880 000 FEET
2 900 000 FEET
735 000 FEET
725 000 FEET
Appanoose Creek
Blue Creek
MARAIS DES CYGNES RIVER
ATCHISON TOPEKA AND SANTA FE
MISSOURI PACIFIC
Richter
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000


N
(Joins sheet 9)
R. 19 E.
2 925 000 FEET
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
T. 16 S.
735 000 FEET
725 000 FEET
2 905 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Eightmile Creek
Sand Creek
Wilson Creek
Appanoose Creek
Marais Des Cygnes River
Nugent Creek
Island Creek
MT. EVERGREEN CEMETERY
HOPE CEMETERY
LAND FILL
SEWAGE LAGOON
Ottawa Junction
OTTAWA
(county seat)
ATCHISON TOPEKA AND SANTA FE
MISSOURI PACIFIC
water
59
68
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

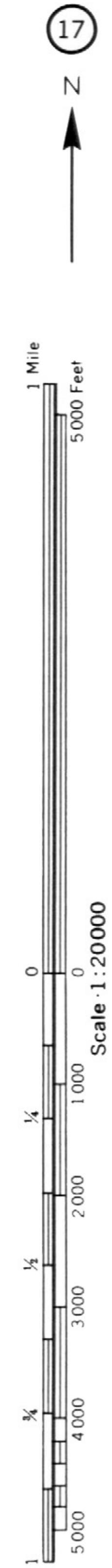

15
N
R. 19 E.
R. 20 E.
T. 16 S.
2 930 000 FEET
2 950 000 FEET
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 21)
(Joins sheet 14)
ATCHISON TOPEKA AND SANTA FE
MISSOURI PACIFIC
OTTAWA
(county seat)
MARAIS DES CYGNES RIVER
Tauy Creek
Wolf Creek
Walnut Creek
Ottawa Creek
LAND FILL
INDIAN CEMETERY
water
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 16



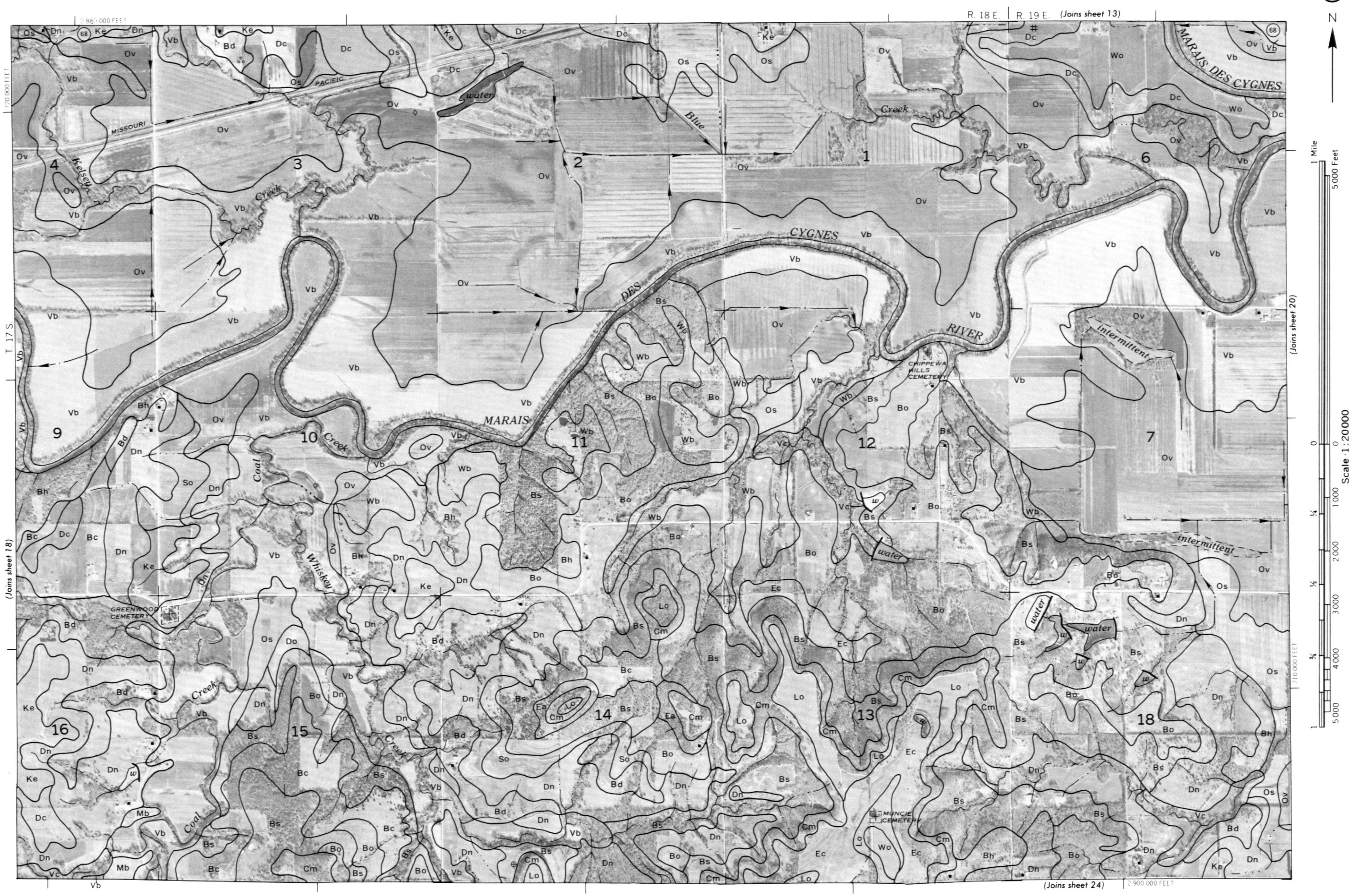

R. 21 E.
2 975 000 FEET
740 000 FEET
T. 16 S.
(Joins sheet 16)
Hickory
Creek
Turkey
Creek
MIAMI COUNTY
(Joins inset)
2 980 000 FEET
725 000 FEET


R. 21 E.
2 975 000 FEET
(Joins lower left)
720 000 FEET
T. 17 S.
Turkey
Creek
(Joins sheet 22)
MARAIS DES CYGNES RIVER
MIAMI COUNTY
(Joins sheet 28)
2 980 000 FEET
710 000 FEET

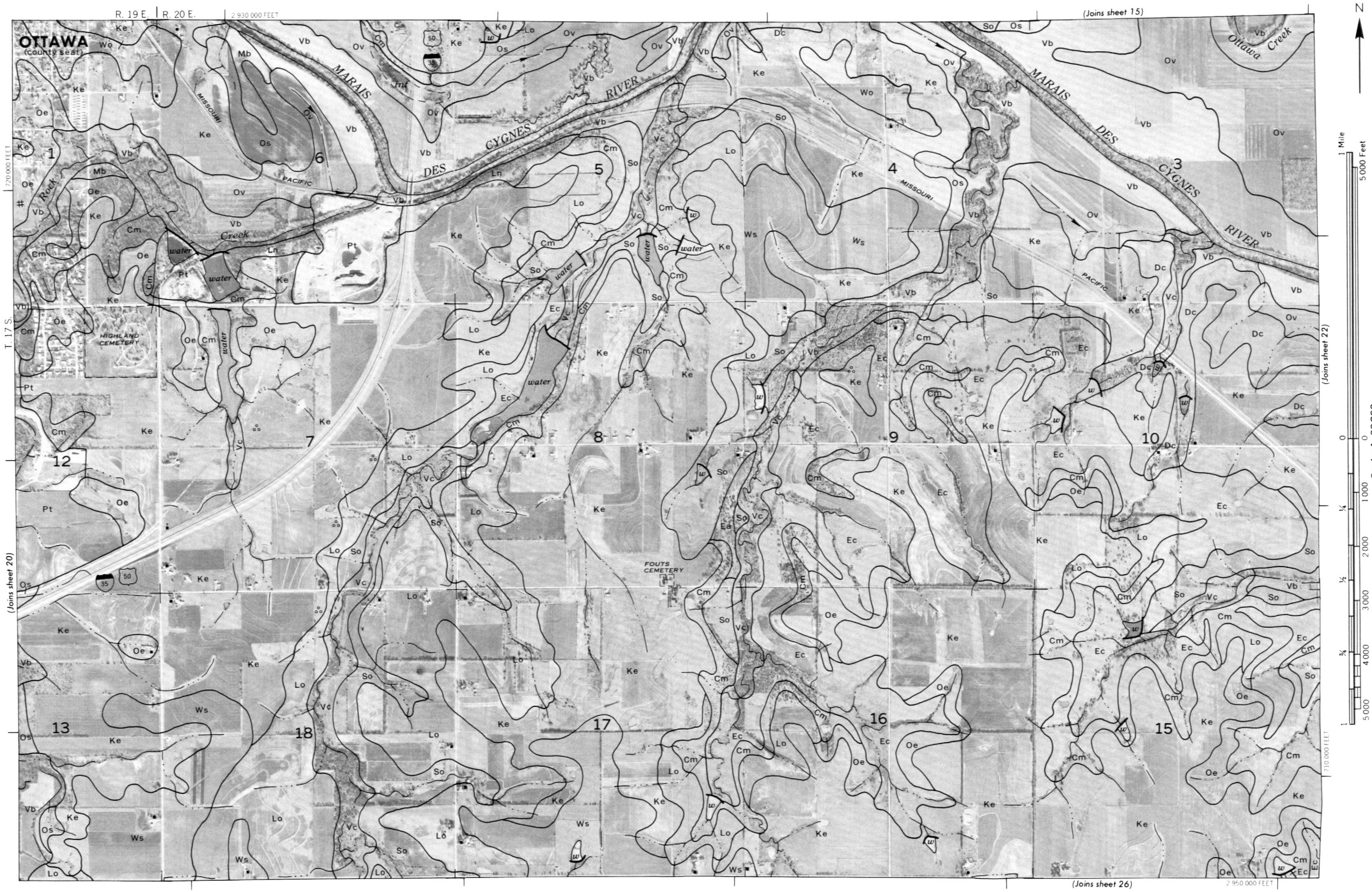

17
N
1 Mile
5000 Feet
Scale 1:20000

(18)

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 18

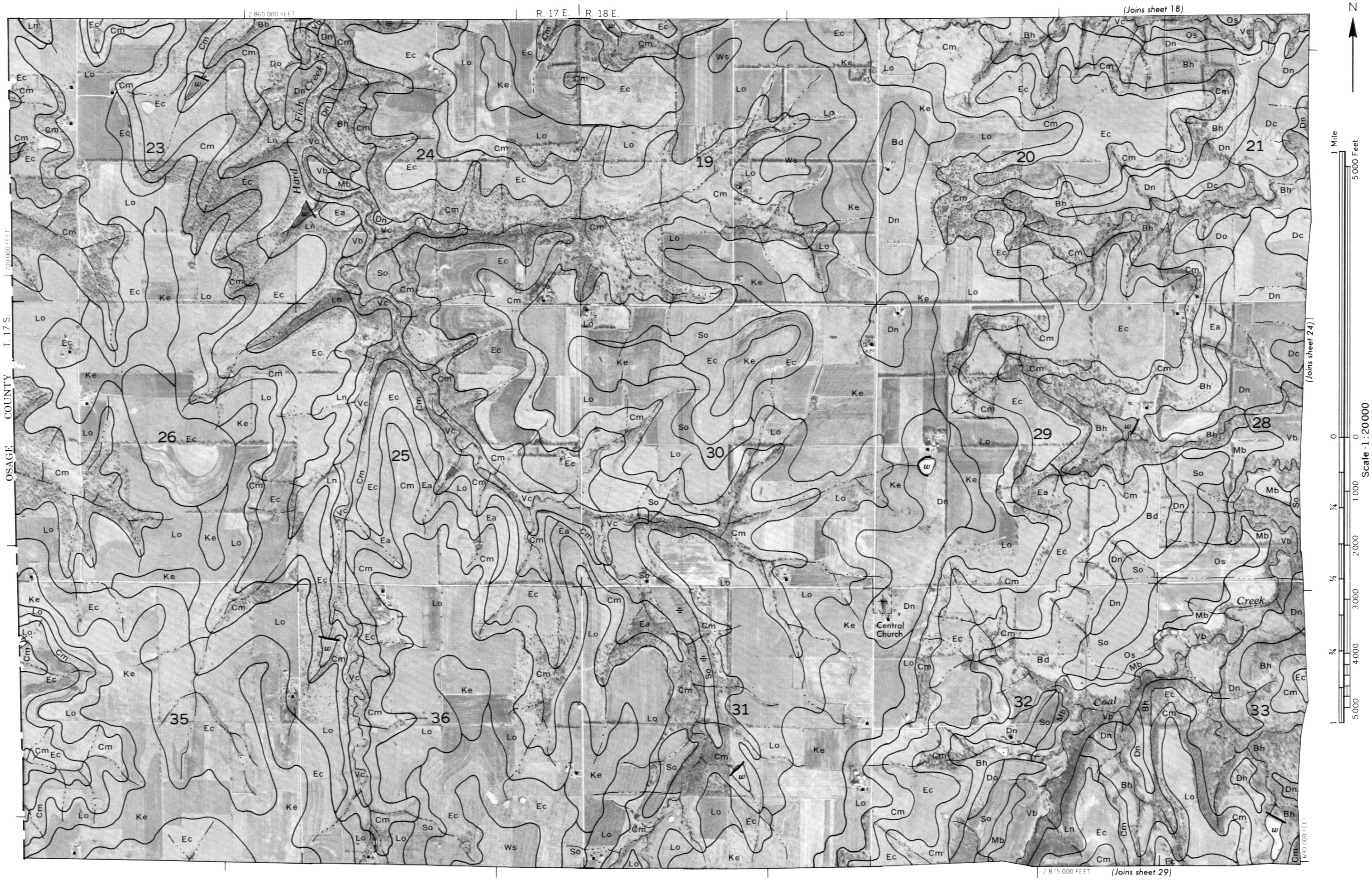

19
N
R. 18 E.
R. 19 E.
(Joins sheet 13)
(Joins sheet 20)
(Joins sheet 24)
(Joins sheet 18)
2 880 000 FEET
2 900 000 FEET
720 000 FEET
710 000 FEET
T. 17 S.
MISSOURI
PACIFIC
water
Blue
Creek
Kelsey
Creek
MARAIS DES CYGNES
DES
CYGNES
MARAIS
RIVER
intermittent
CHIPPEWA HILLS CEMETERY
Coal
Creek
Whiskey
Creek
GREENWOOD CEMETERY
MUNCIE CEMETERY
1 Mile
5000 Feet
Scale 1:20000

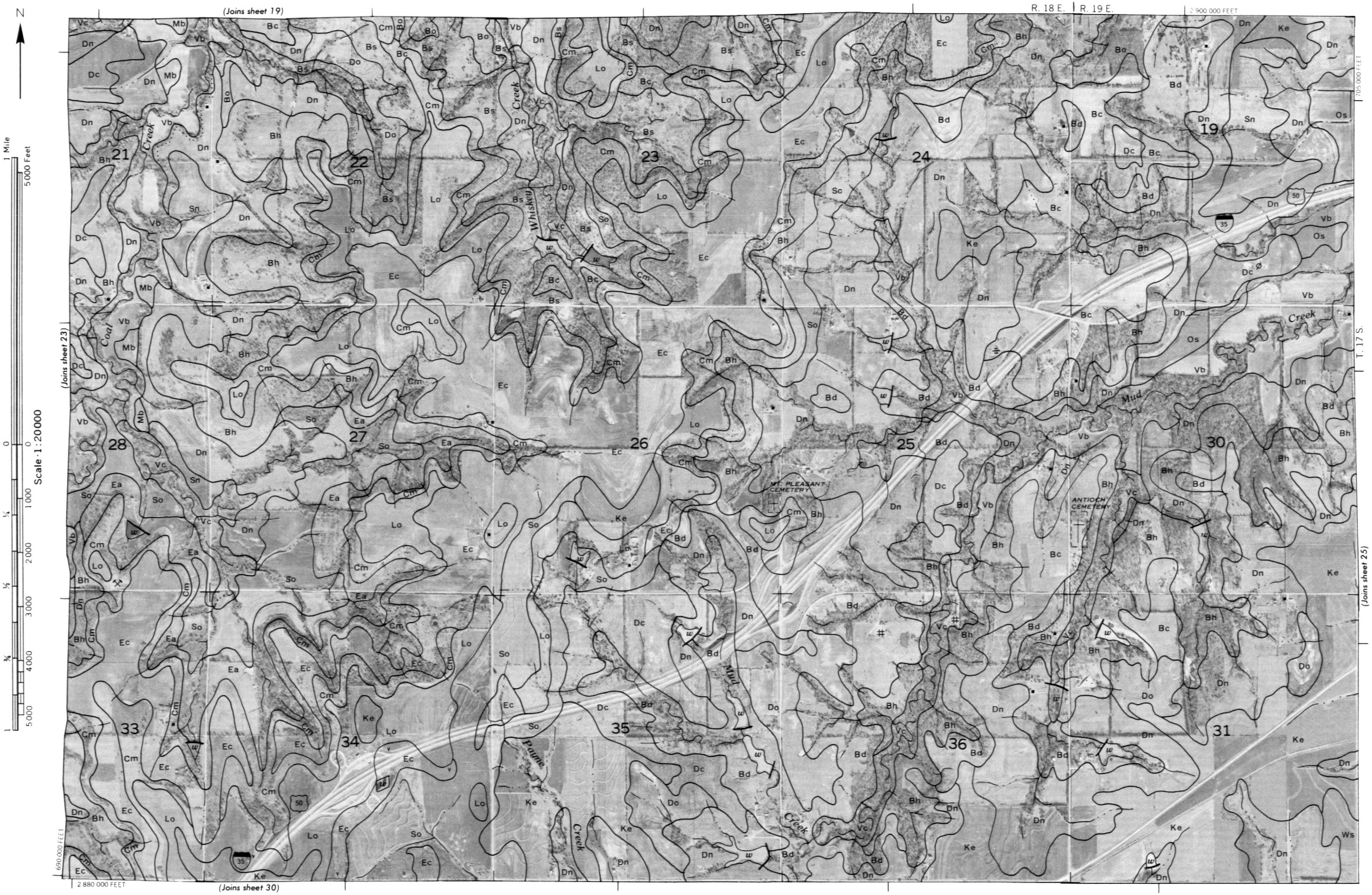

N
(Joins sheet 14)
R. 19 E.
2 925 000 FEET
OTTAWA
(county seat)
Ottawa University
MARAIS DES CYGNES
Intermittent
Island
Creek
Nugent
Robinson
Mud
Rock
SANTA FE
AND
TOPEKA
ATCHISON
ROSELAWN CEMETERY
water
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 25)
T. 17 S.
720 000 FEET
710 000 FEET
2 905 000 FEET
1 Mile
5 000 Feet
Scale 1:20000


N
R. 19 E.
R. 20 E.
2 930 000 FEET
(Joins sheet 15)
OTTAWA
(county seat)
HIGHLAND CEMETERY
FOUTS CEMETERY
MARAIS DES CYGNES RIVER
Rock Creek
Ottawa Creek
MISSOURI PACIFIC
720 000 FEET
T. 17 S.
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 26)
2 950 000 FEET
710 000 FEET
35
50
water
Scale 1:20000
1 Mile
5000 Feet
0
1/4
1/2
3/4
1000
2000
3000
4000
5000

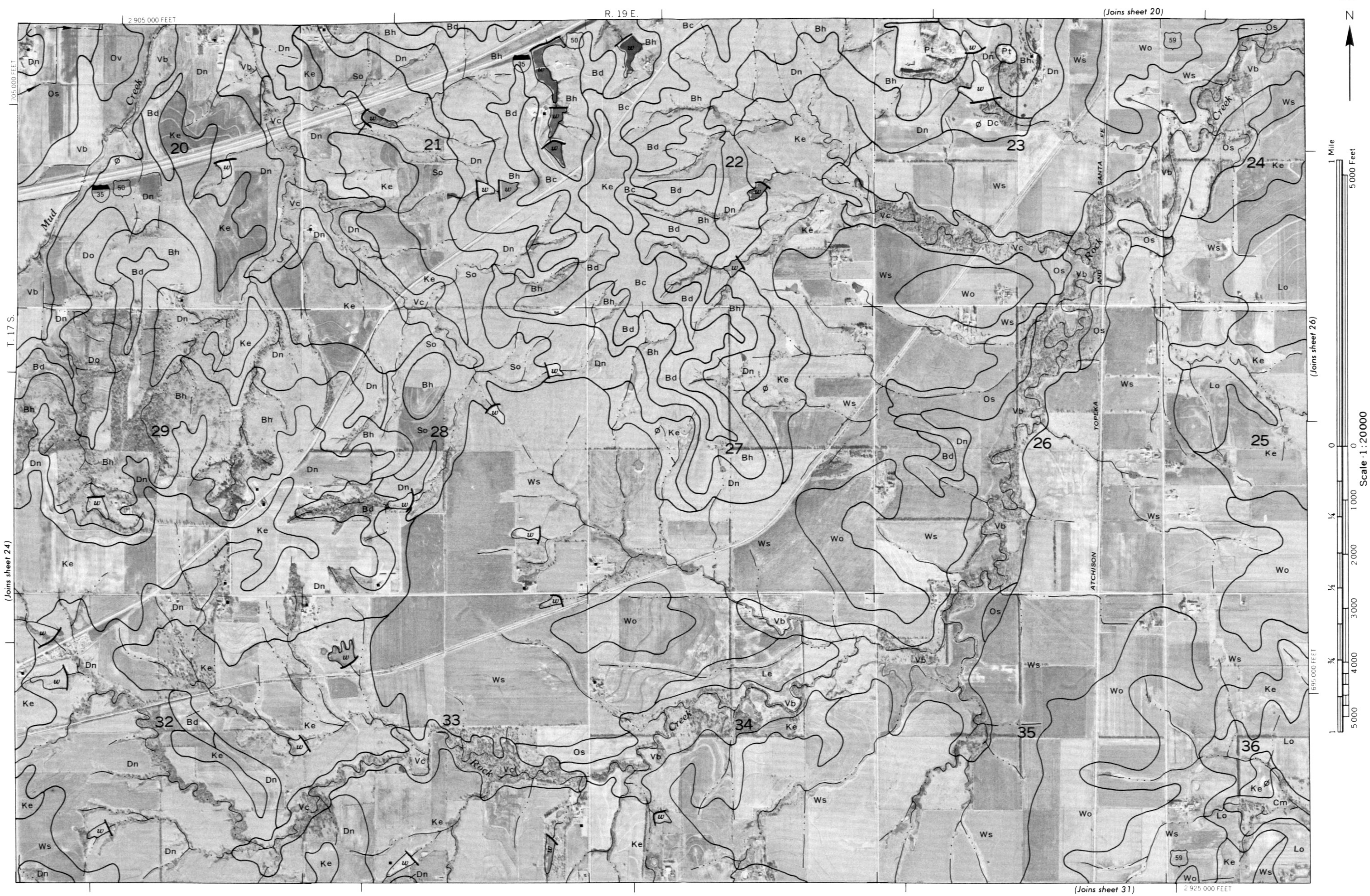
22

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 22


N
2 860 000 FEET
R. 17 E.
R. 18 E.
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 29)
2 875 000 FEET
720 000 FEET
690 000 FEET
T. 17 S.
OSAGE COUNTY
Hard Fish Creek
Coal Creek
Central Church
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Scale 1:20000
1 Mile
5000 Feet


N
(Joins sheet 19)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 30)
R. 18 E.
R. 19 E.
T. 17 S.
2 900 000 FEET
705 000 FEET
690 000 FEET
2 880 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Coal Creek
Whiskey Creek
Mud Creek
Pottawatomie Creek
MT. PLEASANT CEMETERY
ANTIOCH CEMETERY
35
50

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 25



R. 19 E. | R. 20 E.

(Joins sheet 21)

(Joins sheet 25)

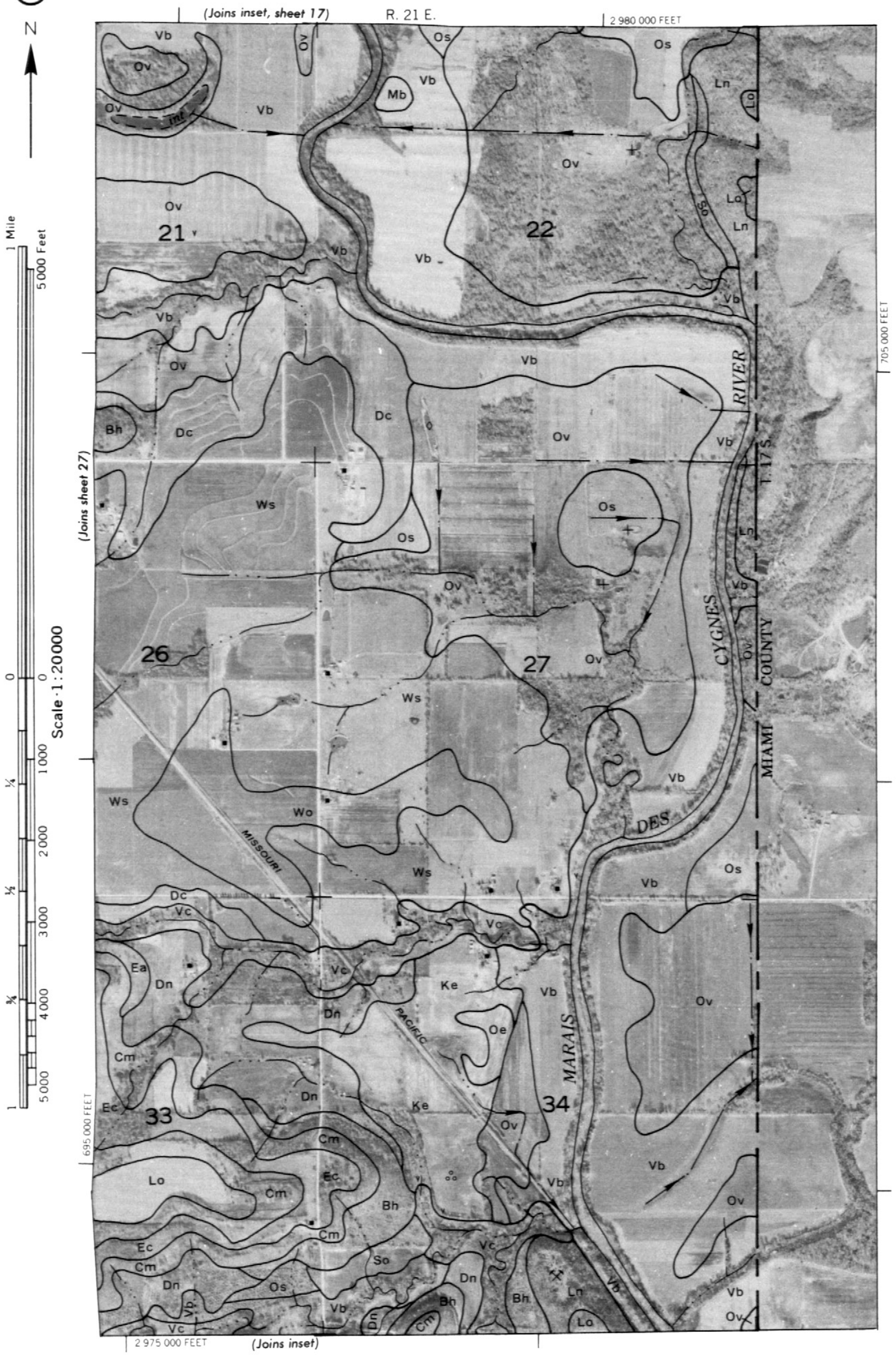
(Joins sheet 27)

(Joins sheet 32)

N

1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1


N
(Joins sheet 22)
(Joins sheet 28)
(Joins sheet 33)
(Joins sheet 26)
R. 20 E.
R. 21 E.
T. 17 S.
2 955 000 FEET
2 970 000 FEET
705 000 FEET
695 000 FEET
Middle
Creek
MISSOURI
PACIFIC
Rantoul
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


N
(Joins inset, sheet 17)
R. 21 E.
2 980 000 FEET
(Joins sheet 27)
705 000 FEET
695 000 FEET
2 975 000 FEET
(Joins inset)
T. 17 S.
MIAMI COUNTY
MARAIS DES CYGNES RIVER
MISSOURI PACIFIC
21
22
26
27
33
34
1 Mile
5 000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000


(Joins lower left)
R. 21 E.
2 982 000 FEET
690 000 FEET
680 000 FEET
(Joins sheet 33)
2 977 000 FEET
(Joins sheet 39)
T. 18 S.
MIAMI COUNTY
MARAIS DES CYGNES
Hahn Branch
4
3
9
10
16
15

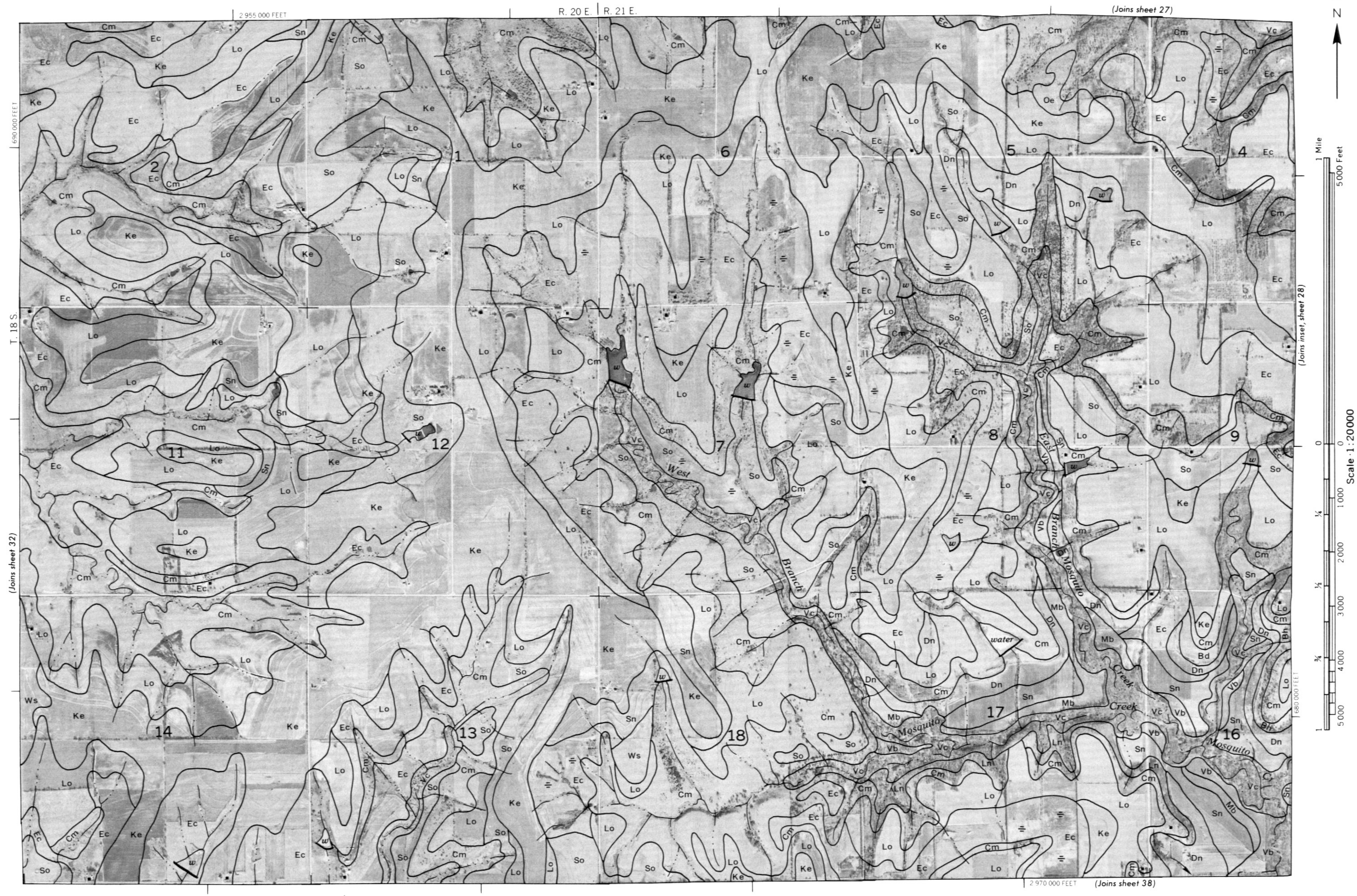

N
(Joins sheet 23)
(Joins sheet 30)
(Joins sheet 34)
2 860 000 FEET
2 880 000 FEET
685 000 FEET
675 000 FEET
R. 17 E.
R. 18 E.
T. 18 S.
OSAGE COUNTY
Ransomville
Williamsburg
Coal Creek
Tequa Creek
Mill Creek
Tequa Cr
ATCHISON TOPEKA AND SANTA FE
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
(Joins sheet 24)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 35)
R. 18 E.
R. 19 E.
2 900 000 FEET
690 000 FEET
T. 18 S.
675 000 FEET
2 885 000 FEET
1 Mile
5000 Feet
Scale 1:20000
ATCHISON
TOPEKA
AND
SANTA FE
Homewood
Payne Creek
Middle Creek
ST. JOHNS CEMETERY
MIDDLE CREEK CEMETERY
water


N
2 905 000 FEET
R. 19 E.
(Joins sheet 25)
690 000 FEET
T. 18 S.
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 36)
680 000 FEET
2 925 000 FEET
Princeton
Middle Creek
Middle Creek
Payne
ATCHISON TOPEKA AND SANTA FE
water
1 Mile
5000 Feet
Scale 1:20000


N
R. 19 E.
R. 20 E.
(Joins sheet 26)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 37)
T. 18 S.
2 950 000 FEET
690 000 FEET
680 000 FEET
2 930 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5 000
¼
½
¾
1
water
Middle
Creek
59

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 33




N
(Joins sheet 29)
R. 17 E.
R. 18 E.
2 880 000 FEET
Williamsburg
MT. HOPE CEMETERY
ATCHISON
TOPEKA
AND
SANTA
FE
Tequa
Creek
Sac
Creek
Silkville
water
T. 18 S.
670 000 FEET
(Joins sheet 35)
660 000 FEET
2 860 000 FEET
(Joins sheet 40)
OSAGE
COUNTY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

35

(Joins sheet 30)

(Joins sheet 34)

(Joins sheet 36)

(Joins sheet 41)

N

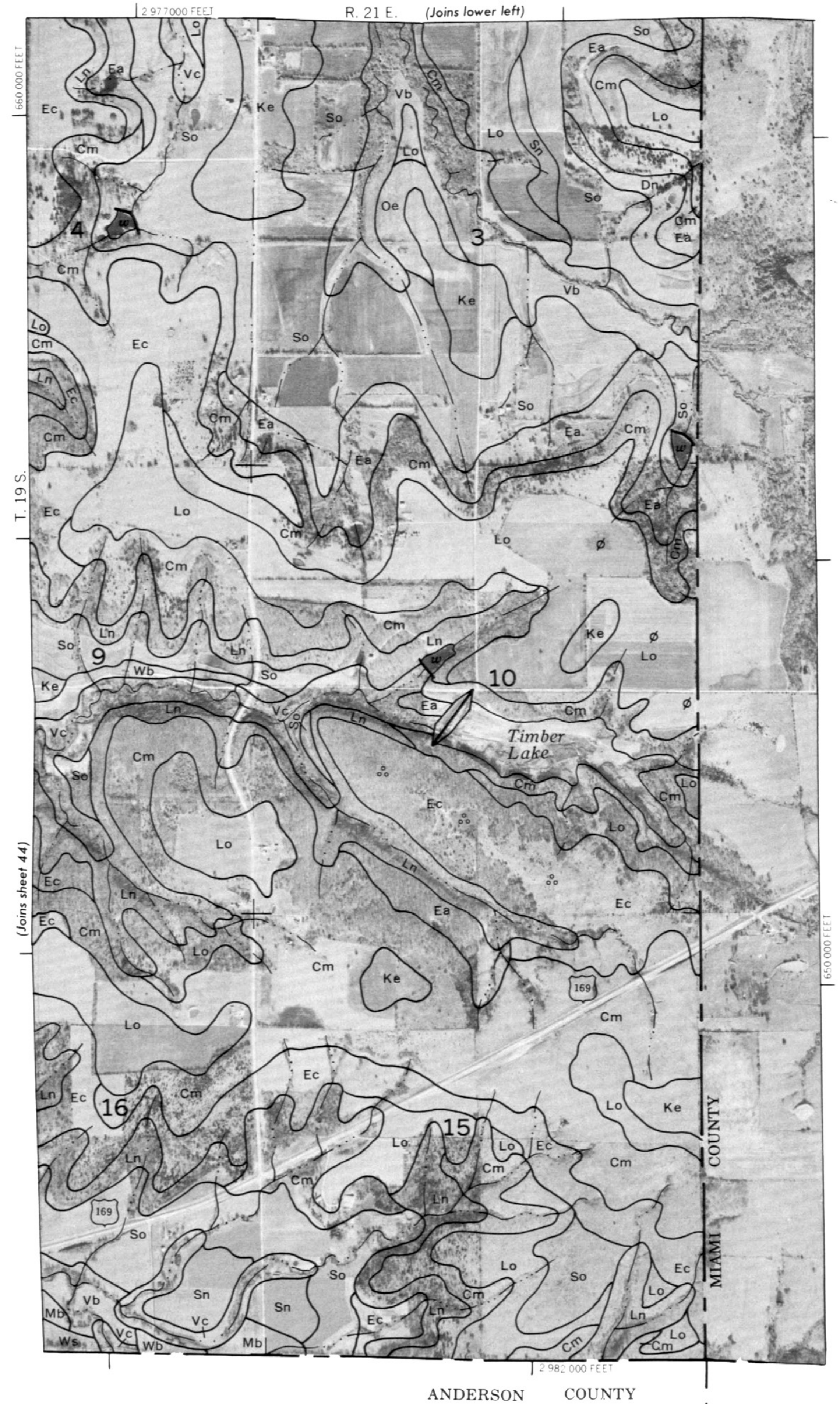
1 Mile
5000 Feet
Scale 1:20000

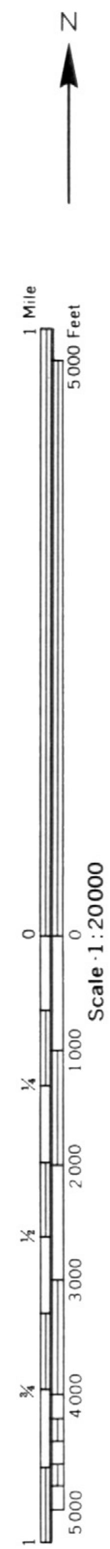

N
(Joins sheet 31)
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 42)
R. 19 E.
T. 18 S.
2 925 000 FEET
675 000 FEET
660 000 FEET
2 905 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
Middle Creek
ATCHISON TOPEKA AND SANTA FE
59
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

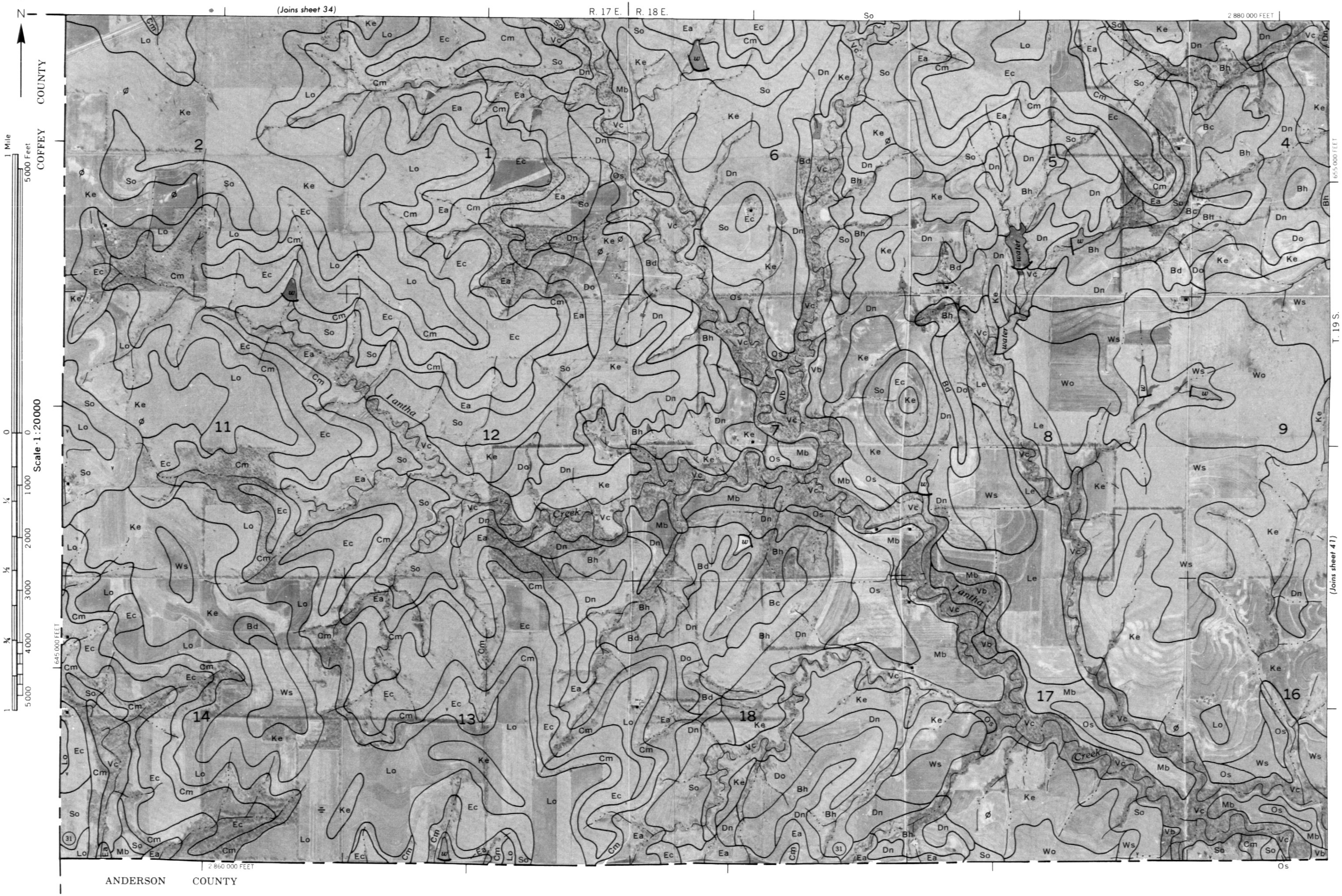

R. 19 E.
R. 20 E.
2 930 000 FEET
675 000 FEET
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 36)
(Joins sheet 43)
665 000 FEET
2 950 000 FEET
T. 18 S.
N
Middle Creek
water
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
Scale 1:20000


N
(Joins sheet 33)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 44)
R. 20 E.
R. 21 E.
T. 18 S.
2 970 000 FEET
675 000 FEET
665 000 FEET
2 955 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
NEEDHAM CEMETERY
Landing Strip
BAKER CEMETERY
North Fork
Sac Branch
Little Sac Branch
Pottawatomie Creek
MISSOURI PACIFIC
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Lo
So
Ke
Ec
Cm
Dn
Bd
Sn
Vc
Vb
Os
Ov
Ws
Dc
Mb
Ln
Ea
Pt
Bh
w

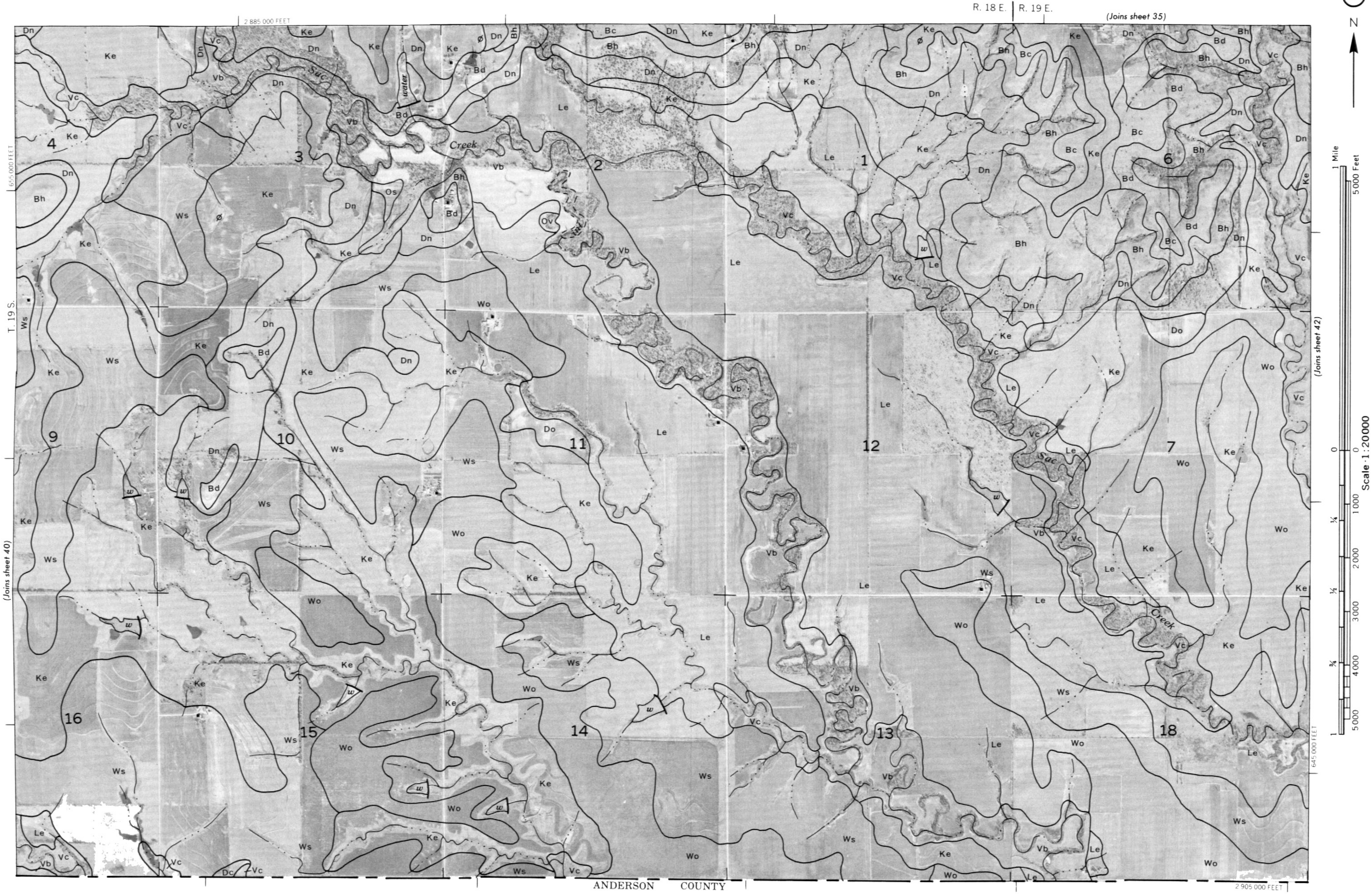

2 977 000 FEET
R. 21 E.
(Joins inset, sheet 28)
675 000 FEET
T. 18 S.
(Joins sheet 38)
Mosquito
Creek
Hahn
Branch
Pottawatomie
Creek
MIAMI COUNTY
MISSOURI
PACIFIC
Lane
LANE CEMETERY
21
22
27
28
33
34
665 000 FEET
(Joins inset)
2 982 000 FEET

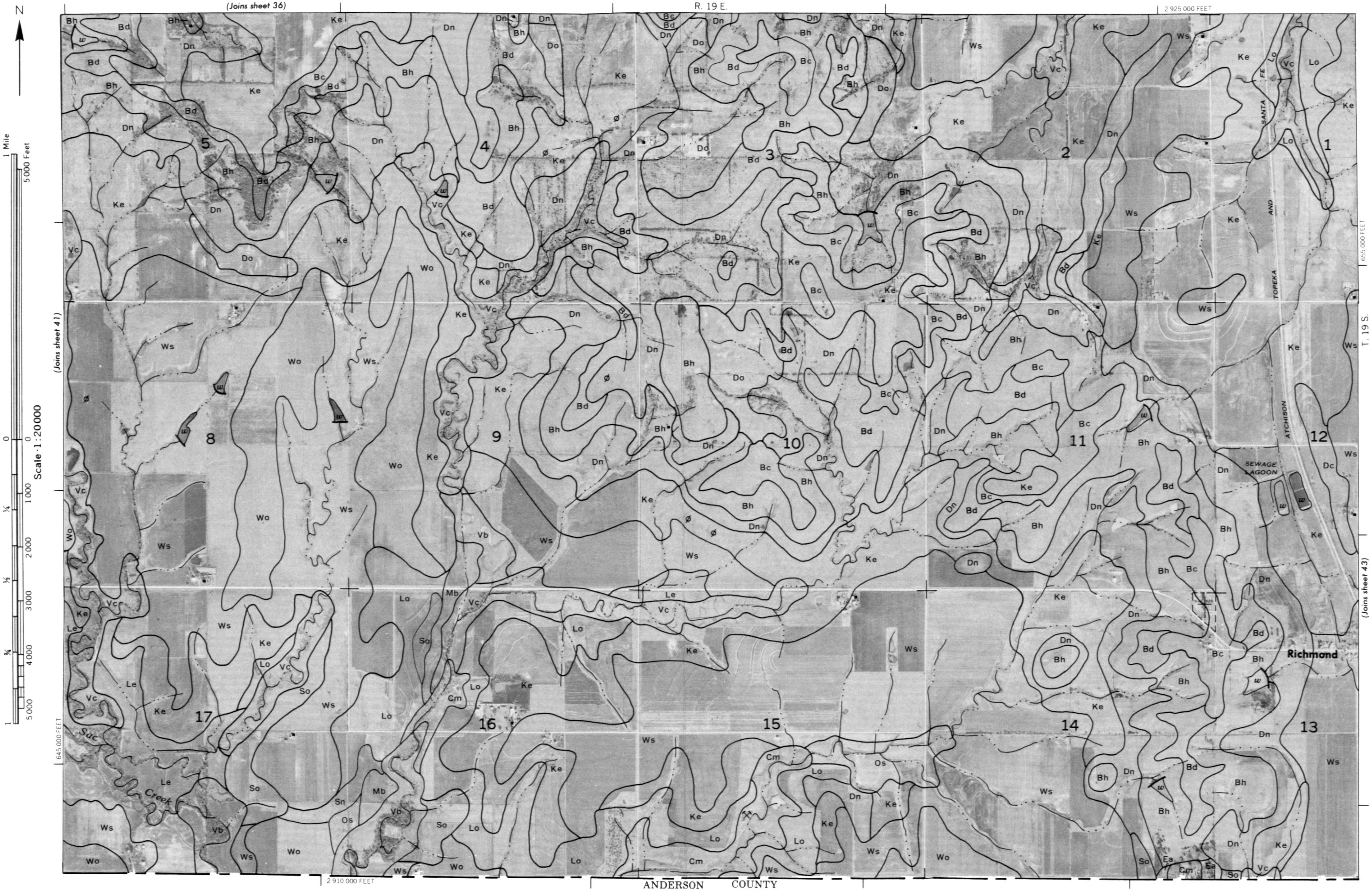

2 977 000 FEET
R. 21 E.
(Joins lower left)
660 000 FEET
T. 19 S.
(Joins sheet 44)
Timber
Lake
169
MIAMI COUNTY
650 000 FEET
3
4
9
10
15
16
2 982 000 FEET
ANDERSON COUNTY


N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000


N
(Joins sheet 34)
R. 17 E.
R. 18 E.
2 880 000 FEET
COFFEY COUNTY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
655 000 FEET
645 000 FEET
T. 19 S.
(Joins sheet 41)
Iantha
Creek
2 860 000 FEET
ANDERSON COUNTY

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 41




N
(Joins sheet 36)
R. 19 E.
2 925 000 FEET
(Joins sheet 41)
T. 19 S.
655 000 FEET
(Joins sheet 43)
645 000 FEET
2 910 000 FEET
ANDERSON COUNTY
SANTA FE
ATCHISON AND TOPEKA
SEWAGE LAGOON
Richmond
Sac Creek
1 Mile
5000 Feet
Scale 1:20000


R. 19 E.
R. 20 E.
2 930 000 FEET
(Joins sheet 37)
N
T. 19 S.
655 000 FEET
(Joins sheet 42)
(Joins sheet 44)
645 000 FEET
2 950 000 FEET
ANDERSON COUNTY
Richmond
Richmond Lake
Gilkey Lake
BEREA CEMETERY
ATCHISON TOPEKA AND SANTA FE
59
1 Mile
5000 Feet
Scale 1:20000

FRANKLIN COUNTY, KANSAS — SHEET NUMBER 44